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GREAT LAKES-ILLINOIS RIVER BASINS COMPREHENSIVE STUDY. INTERIM REPORT, ILLINOIS RIVER BASIN

Public Health Service
Chicago, Illinois

August 1961

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Comprehensive Study

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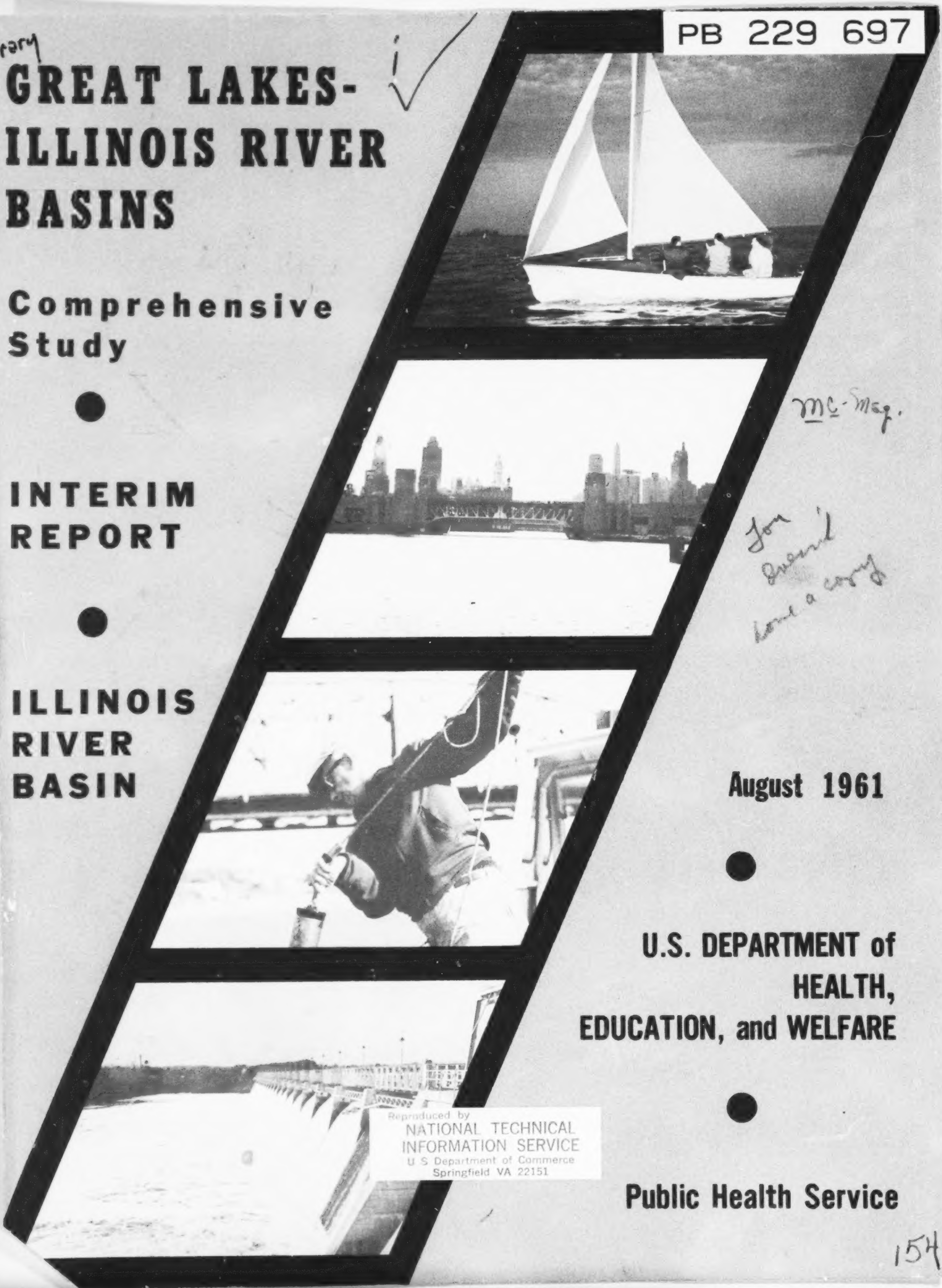

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INTERIM REPORT

GREAT LAKES-ILLINOIS RIVER BASINS COMPREHENSIVE STUDY

1. INTERIM REPORT – ILLINOIS RIVER BASIN

A report to present progress, achievements,
and future direction of this project after
the first year of operations

AUGUST, 1961

PUBLIC HEALTH SERVICE
REGION V
CHICAGO, ILLINOIS

GREAT LAKES-ILLINOIS RIVER
BASINS PROJECT
CHICAGO, ILLINOIS

FIELD OPERATIONS SECTION
ROBERT A. TAFT SANITARY ENGINEERING CENTER
CINCINNATI, OHIO

DIVISION OF WATER SUPPLY AND POLLUTION CONTROL
PUBLIC HEALTH SERVICE

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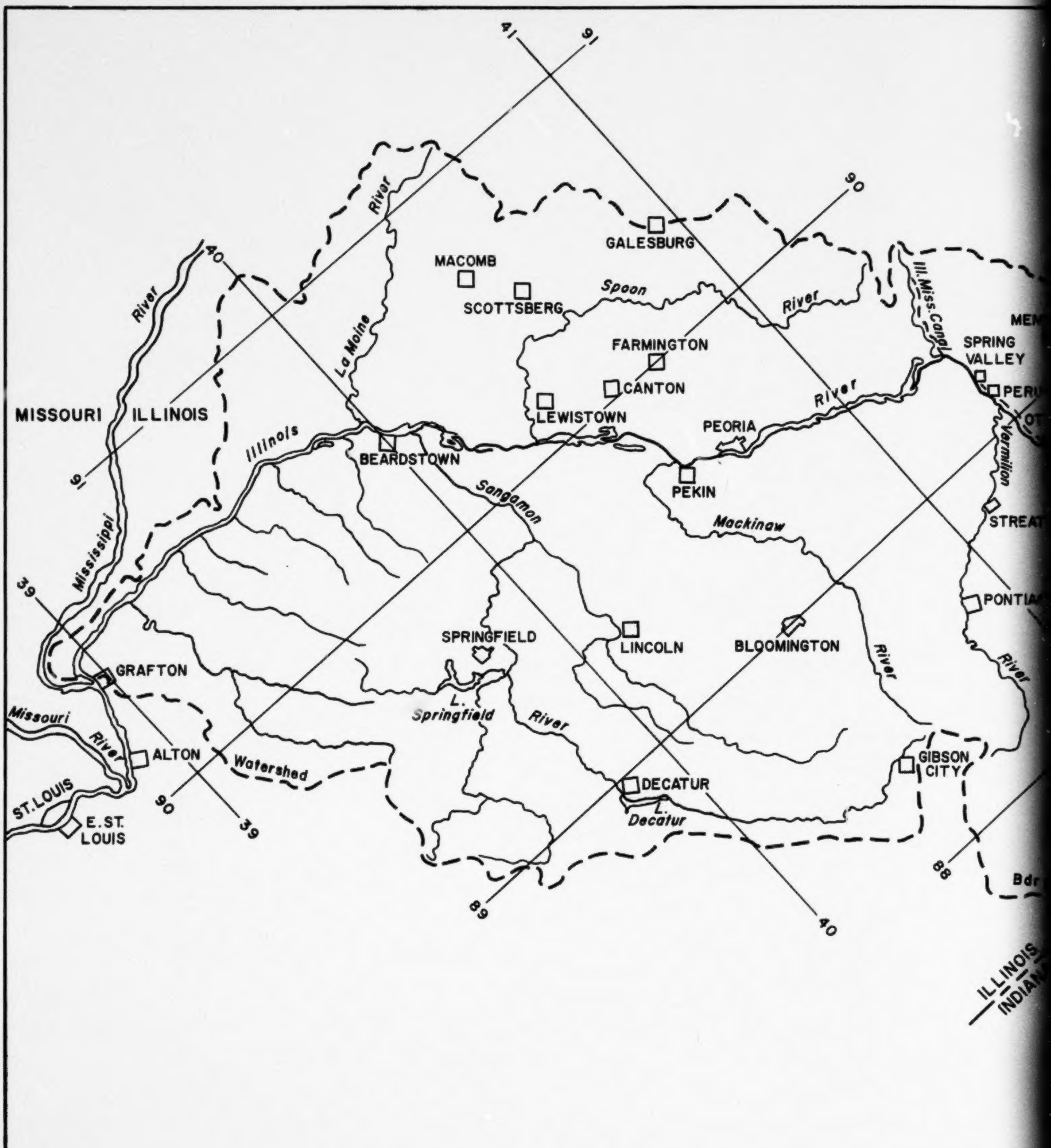
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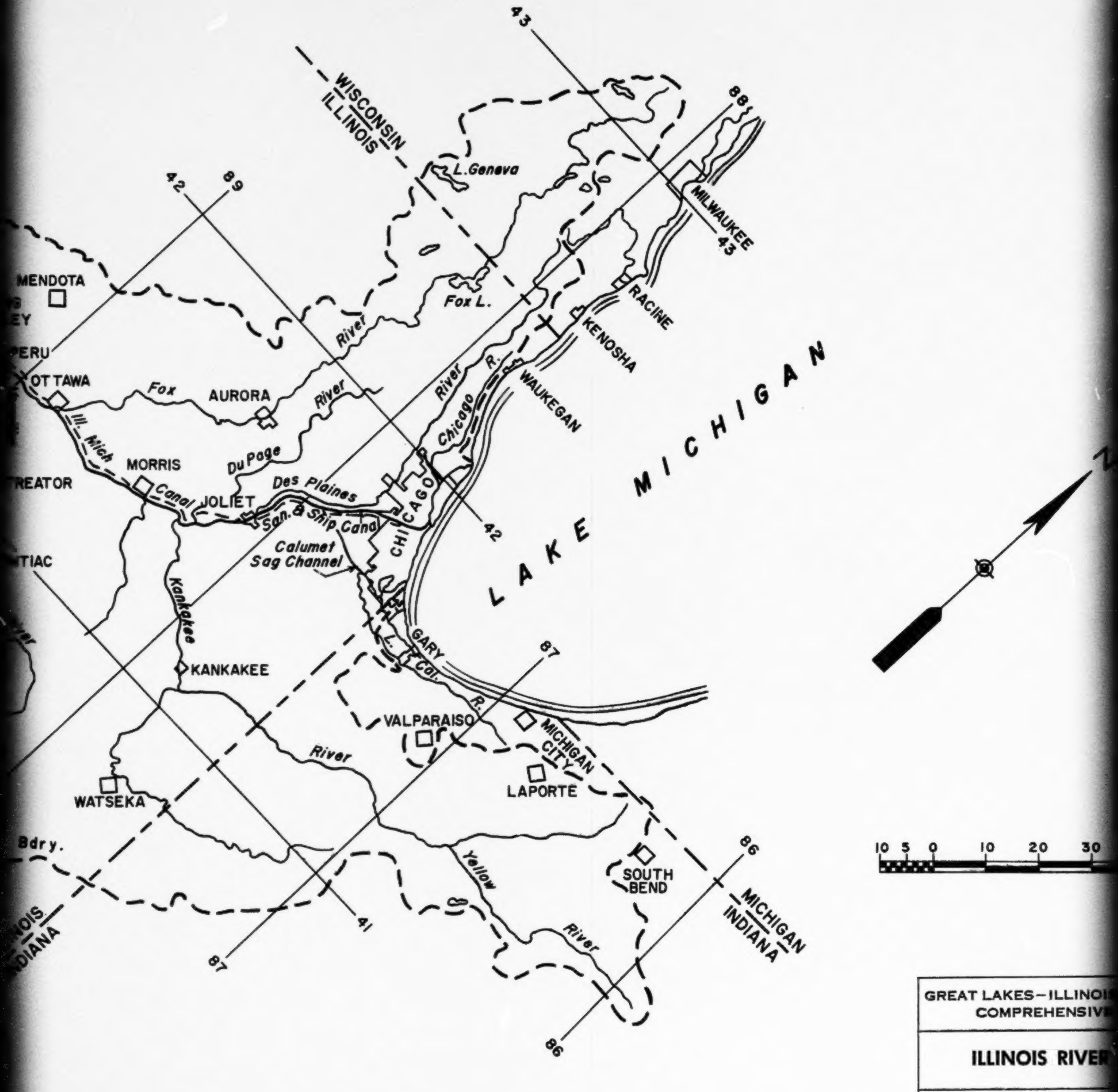
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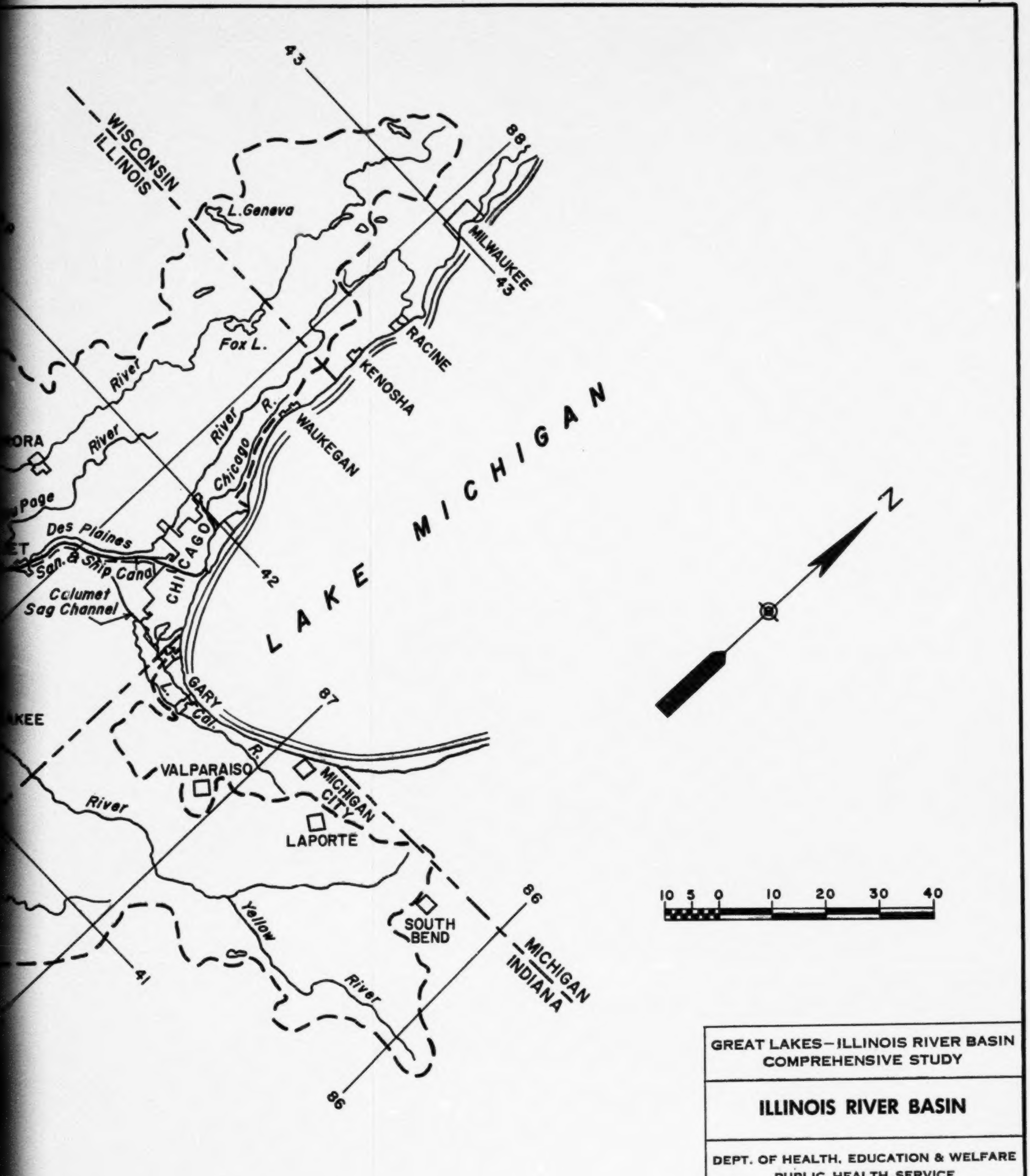
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GREAT LAKES—ILLINOIS RIVER BASIN
COMPREHENSIVE STUDY

ILLINOIS RIVER BASIN

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PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 1

SUMMARY

The report includes data on the Illinois River and waterway is highlighted in the report ~~for 1961~~.

The need for a comprehensive study of water resources, water use, and water quality in the Great Lakes Basin ~~has~~ long been recognized. Following the entry of the United States into the latest litigation concerning the diversion of Lake Michigan water into the Illinois Waterway, the United States Department of Justice requested the Public Health Service to furnish such definitive data and information as would be helpful in advancing testimony pertinent to the complex issues before the Court. At about this same time, the Congress was considering an appropriation to permit a comprehensive water resources study of the Great Lakes-Illinois River Basins by the Public Health Service. In September, 1960, the appropriation bill of the Department of Health, Education and Welfare became law and steps were taken immediately to establish the Great Lakes-Illinois River Basins Project Office at Chicago, Illinois, to conduct the study.

The Comprehensive Water Resources Study is a new and important milestone in the total water resources management effort. It was a logical development evolving from the limited purpose pollution study which was concerned primarily with oxygen balance and bacterial concentrations. The sharpening competition for water by its many varied users has increased to the point that it no longer is asked, "How much waste can the receiving water absorb?" but, "What steps must be taken to improve and protect the quality of this water resource to assure that, within the limits of available water resources, all legitimate water users will have an adequate supply of water of satisfactory quality, not only for today, but for the forseeable future?"

The Comprehensive Water Resources Study is, then, concerned with the balance between water demand and supply; the nature and extent of present and projected water uses, and water quality requirements of these uses; the effect of these uses on water quality, and the development of a plan for maintaining or improving water quality to meet these needs. Combined, the study, the plan, and the management of the water resources to meet the plan objectives, constitute a comprehensive water management program.

In undertaking a Comprehensive Water Resources Study the following steps are involved although not necessarily in the order given:

1. An inventory of available water resources, including potential developments which will result in increasing the useable water supply.
2. A study and evaluation of the quality of all water resources.
3. An inventory of all water uses.
4. A study of the human and physical resources of the areas and potentials for future growth.
5. Development of projections of future water demand for all legitimate uses, the quality of water needed for such uses, and the impact of water uses on water quality.
6. Preparation of a comprehensive plan which will include a study of the balance of supply against demand, determination of the quality of water available to meet requirements of various projected water uses, and a recommended program necessary to maintain and improve water quality to assure an adequate supply of water of satisfactory quality for all legitimate water uses, both for today and for some fifty years ahead.

It must be recognized that in a dynamic economy, changes which cannot be foreseen will occur. It will be necessary, therefore, that the program be reviewed periodically and suitable adjustments made to accommodate any new conditions found.

At the request of the Solicitor General of the United States Department of Justice, and as directed by the Surgeon General of the United States Public Health Service, the initial efforts of project personnel have been directed toward the following:

1. Assembly of an inventory of all points of inflow into the Chicago River, Chicago Sanitary and Ship Canal, the Calumet-Sag Channel, and their tributaries.
2. Measurements and analyses of municipal and industrial wastes being discharged at such points of inflow.
3. Determination of the effect of such discharges on water quality of the Illinois Waterway under present rate of flow.
4. Determination of water quality of the Illinois Waterway under present and various decreased rates of flow.
5. Consideration of methods of improving water quality of the Illinois Waterway.

This report to the Justice Department presents the progress, achievements and direction of the project as of July 1, 1961. Introductory and background information, and extensive tabular material are contained in the Appendixes.

Since November 15, 1960, project personnel have been in the field developing inventories of water resources, water uses and sources of wastes in the Chicago Metropolitan Area tributary to the Illinois Waterway. The inventories contained in this report are approximately 95% complete.

A water quality study was conducted of the waterway in Greater Chicago from April 24 to May 21, 1961, to define existing water conditions and to obtain information useful in planning continuing and more intensive stream investigations. The study encompassed physical, chemical, biochemical, biological, bacteriological and radioactive parameters. A study was also made of the effluent quality and treatment efficiencies at the three major sewage treatment works of the Metropolitan Sanitary District.

This Study is the first systematic procurement of detailed field data on the waterway in the Greater Chicago Area which is necessary to evaluate the contributing waste load and the natural purification capacities of the waterway. Information is not comprehensive enough at this time to permit firm mathematical interpretations of all the variables affecting stream conditions so as to develop quantative relationships between varying pollutional loads and flow requirements. However, existing data coupled with engineering experience and judgment permit qualitative evaluation.

Preliminary assessments of the resulting stream conditions have been advanced. Various possibilities of improving the water quality of the Illinois Waterway within the Greater Chicago Area have been expounded. These discussions have been limited to technical considerations with the exclusion of economic features and the possible impact of research development.

DISCUSSION OF FINDINGS

This is an interim report which presents progress and results achieved during the first stages of the Comprehensive Water Resources Study of the Great Lakes - Illinois River Basins. Such conclusions as are tentative are subject to revision as additional data become available. This interim report is directed primarily to the Greater Chicago Area.

WATER SUPPLY

The Lake Michigan-Illinois River Basins region is recognized as an area endowed with a reasonably adequate supply of water. Many of the smaller communities use ground water as the source of their municipal supplies. Industries, in addition to tapping municipal supplies, have sought ground water sources although many locate along the waterway to utilize the available surface supply. There appears to be developing a shortage in ground water and the water table has been dropping.

The early residents in Chicago also tapped ground water for their needs. In 1840 Lake Michigan became the source of Chicago's Municipal supply. In order to protect this water supply, Chicago pumped some of its sewage, slightly diluted with lake water, from the South Branch of the Chicago River into the Illinois and Michigan Canal as early as 1861. Subsequently, contamination of the lake supply led to the Sanitary District Law which was passed by the Illinois legislature, and the Chicago Sanitary District was established in 1889. Through the efforts of the Chicago Sanitary District, the Chicago Sanitary and Ship Canal, used to convey the municipal wastes away from the source of the public water supply in Lake Michigan, was completed.

Full recognition is rendered unto the City Fathers of Chicago and the engineers of the Sanitary District for the concept and promotion of complete separation of water supply and municipal wastes. It must be recalled that in those days water treatment was in its infancy, and that control of pathogens by chlorination was virtually unknown. Likewise, sewage treatment was not common and little was known concerning effective waste treatment. Therefore, the practical and effective solution was to prevent the sewage from reaching the water supply.

Since the 1890's the art and science of water treatment and waste disposal have advanced considerably. Ultimately, the permanent solution to the Chicago sanitary problem must be based upon: advanced knowledge in water treatment, sewage collection, treatment and disposal; construction of needed facilities; and financial ability.

WASTE TREATMENT

Waste treatment is practiced to a high degree in the basin. The largest source of sewage is the Metropolitan Sanitary District of Chicago, which operates three large sewage treatment works. BOD removal at these plants during the April-May study period averaged as follows: Northside Treatment Works - 91.1 percent; Calumet Treatment Works - 89.2 percent; and West-Southwest Treatment Works - 87.5 percent. The sewage treatment plants of the District were performing a Herculean task, treating an average of 1,238 million gallons daily during the study. Yet, pollution persists and improvements can be achieved in the over-all metropolitan disposal program.

A large number of storm sewers drain to the waterway, and this drainage, plus sewage overflow and bypass, is discharged untreated. In addition, some untreated and treated wastes from industry in the Metropolitan Area discharge to the waterway. There are insufficient available data on this aspect to completely appraise the full effect of these wastes on the water quality of the waterway.

PUBLIC HEALTH

The discharge of sewage to bodies of water creates potential health hazards. Pathogenic organisms are contained in raw sewage and in many treated effluents. These organisms are dispersed in the stream over long distances, permitting possible contact with the human population. Such contact may occur during recreational boating, navigation, working along the river banks, use of the untreated river water in industrial operations, and possibly, farther downstream, swimming and fishing. Use of the stream as a source for public water supply increases the public health hazards of pathogenic discharges.

Three highly significant potential sources of radioactive liquid wastes exist in the Upper Illinois Waterway System. These are the Argonne National Laboratory, the Dresden Nuclear Power Station, and the Armour Research Foundation Reactor. By the nature of the activities and the nuclear materials handled at these installations, their potential as sources of radioactive pollution is great. However, because of the great care taken in the design and operation to minimize the amount of activity discharged, their actual contribution of radioactivity to the aquatic environment has been minimal to date. It can reasonably be expected that this contribution will remain low in the future with a continuation of present operating procedures. The potential of these installations for contamination of receiving waters through accidental release of radioactive materials was not investigated.

The extensive use of radioisotopes for industrial, medical, and educational use in the Chicago area presents a much less significant source of radioactive pollution. Though a large amount of radioactive materials is handled in this manner, the portion of this activity which actually enters the city's sewage can be expected to be quite small. A single set of samples reported on herein failed to reveal the definite presence of any of these radioisotopes. A considerably greater amount of sampling of the City's waste effluent will be required to establish the amount of activity added by isotope users. In any case, however, this amount could be expected to be relatively small.

The findings of this preliminary investigation indicate that the radioactive materials presently known to be discharged to the Upper Illinois River Waterway do not now, under existing conditions, present a significant hazard.

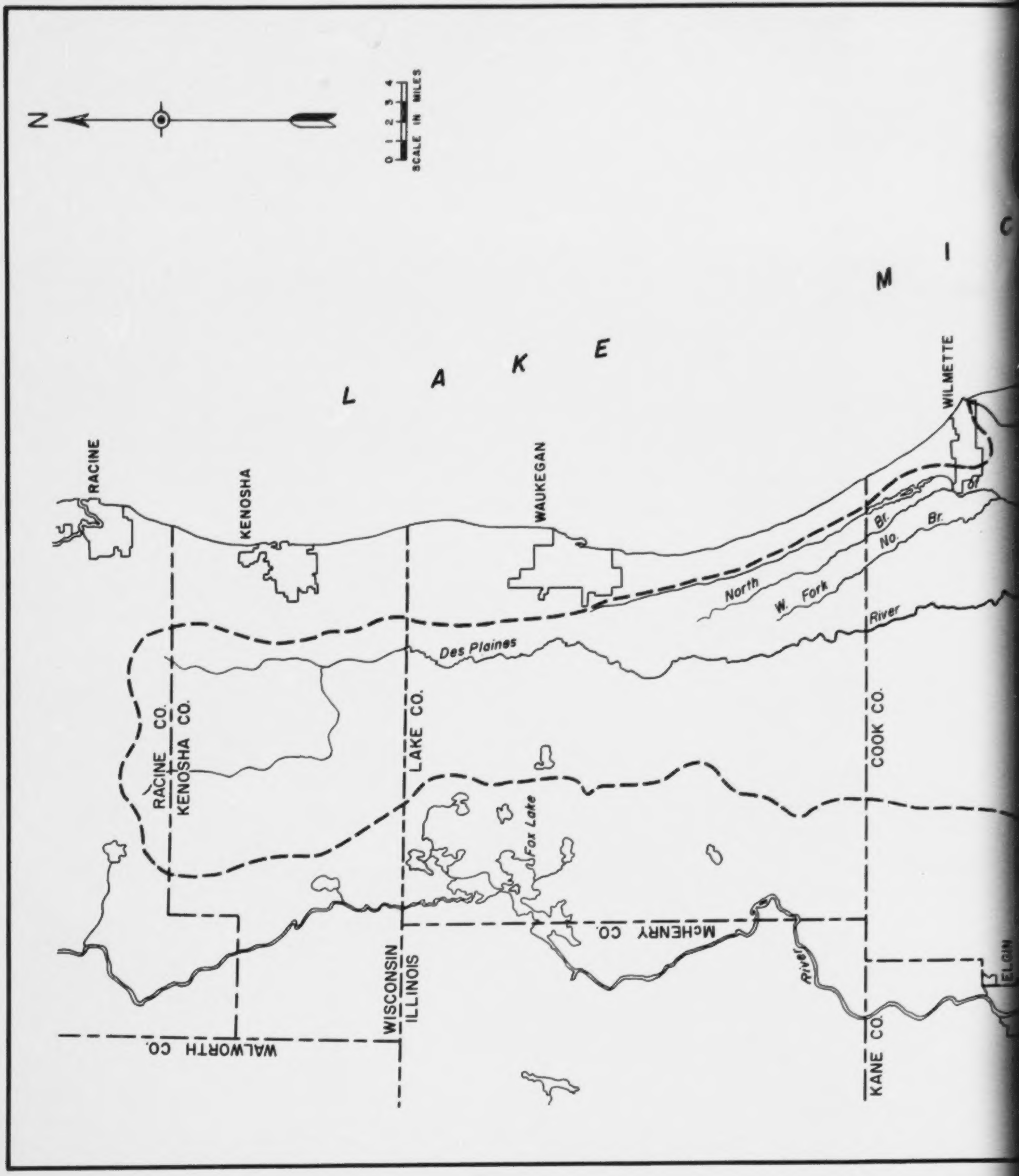
STREAM CONDITIONS

The use of a flowing body of water for conveyance and ultimate disposal of treated sewage and industrial wastes is generally accepted practice. Associated with this use is the responsibility of the user to maintain stream conditions so as to protect the public health, avoid nuisances, and to minimize damage to other water uses.

The Illinois Waterway in the vicinity of Greater Chicago in its present state is polluted. The waterway remains seriously degraded through the Brandon Pool. Recovery begins in the Dresden Island Pool where the Kankakee River joins the Des Plaines River to form the Illinois River.

Even the limited investigation of the Illinois Waterway in the Chicago Metropolitan Area that has been possible since the Great Lakes-Illinois River Basins Comprehensive Project started eight months ago leaves no basis for doubt regarding the quality of water in the waterway. On the basis of every criterion commonly used to judge the effects of sewage on water quality, the waterway is seriously degraded throughout the Metropolitan Area, and for many miles downstream. Evidences of the extreme pollution of the waterway include:

1. Visual aesthetic nuisances, most of which have been observed occasionally and others frequently throughout the waterway.
   - a. Condoms.
   - b. Feces.
   - c. Grease and heavy oil.
   - d. Oil slicks.
   - e. Detergent foam.
   - f. A few dying and many dead fish.
   - g. Gas bubbles from sludge deposits, in some areas giving the appearance of a heavy shower on the water.
   - h. Sludge clumps rising to the surface.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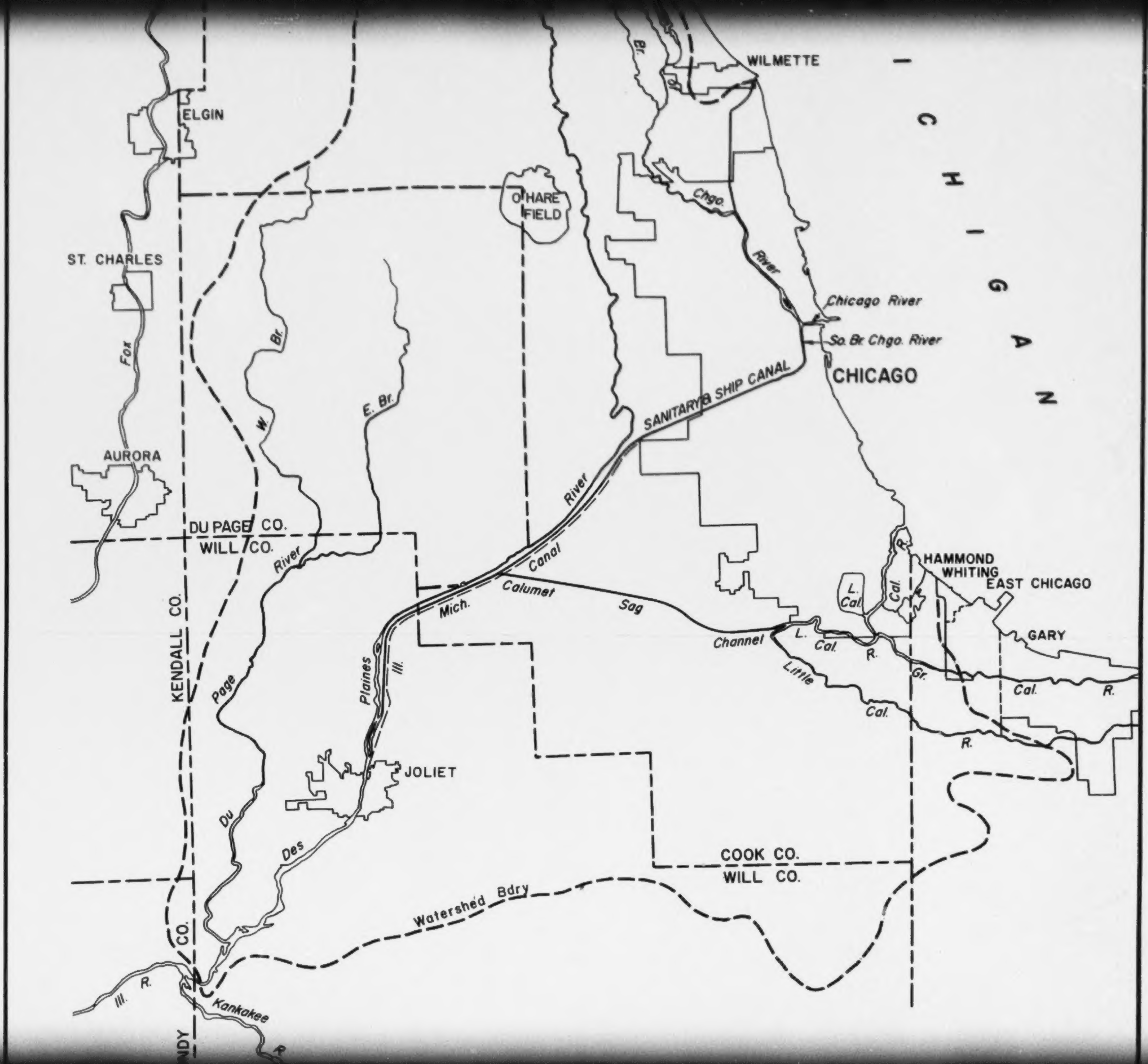

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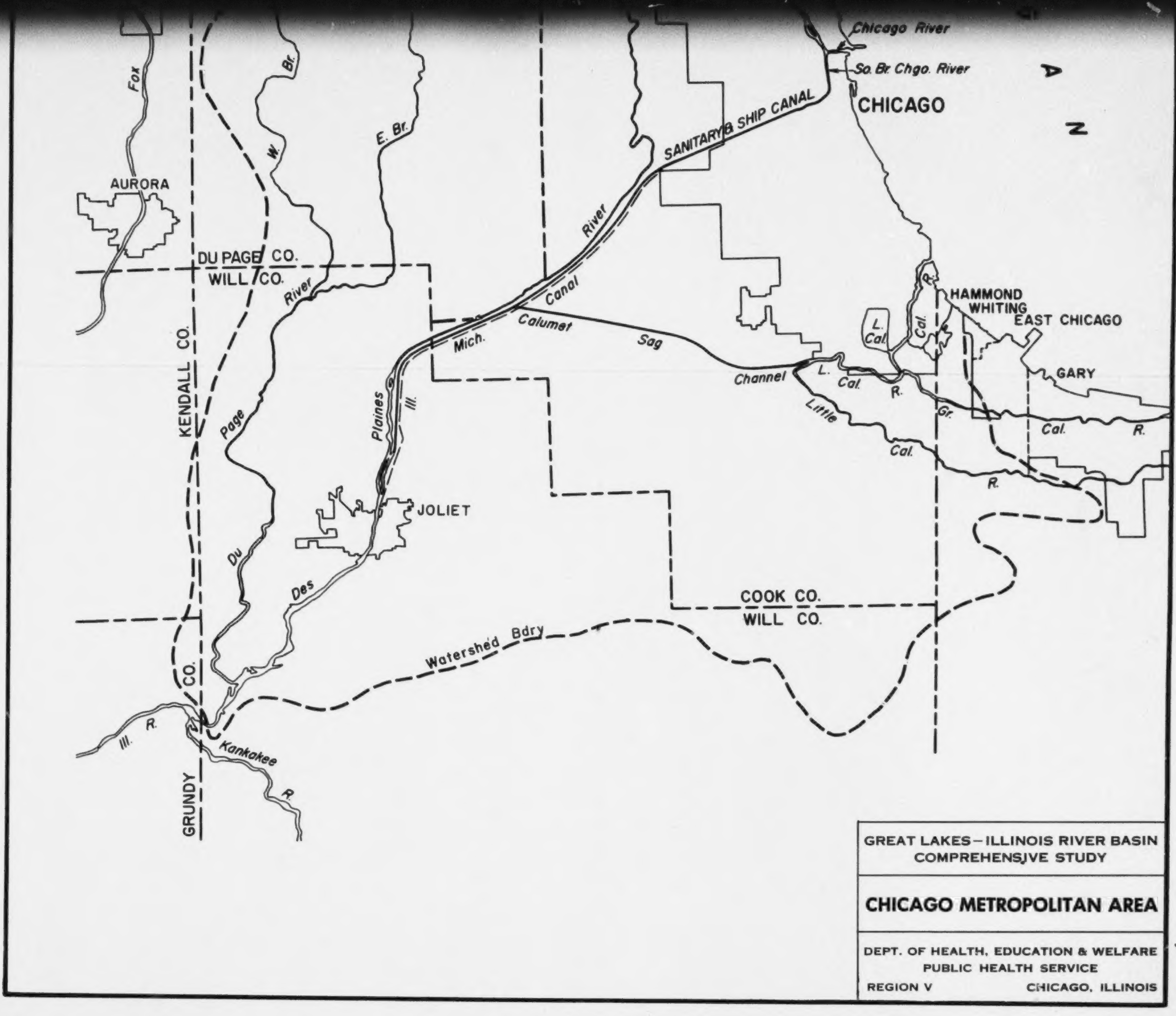
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GREAT LAKES – ILLINOIS RIVER BASIN
COMPREHENSIVE STUDY

CHICAGO METROPOLITAN AREA

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FIGURE 2

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i. Paper products.
j. Discarded lumber, trees, and tree limbs.
k. Metal cans.
l. Unidentified debris.
m. Grey to dark color of water.

2. Odor nuisances.

   a. Septic odors in limited areas.
   b. Fresh sewage odors near some sewers.
   c. Activated sludge effluent odor for many miles below West-Southwest Sewage Treatment Works.

3. Sludge deposits, throughout waterway.

   a. Sewage sludges with septic odors.
   b. Mixtures of sewage and oily sludges.
   c. Literally innumerable sludge worms.

4. Biological organisms.

   a. Very nearly total absence of bottom organisms with the exception of sludge worms.
   b. Clean water plankton diminishing and being replaced by pollution tolerant forms on proceeding downstream from the lake.

5. Temperature.

   a. A net rise of 7.1°C in temperature from Lake Michigan to Dresden Island Pool, which could cause serious biological damage in a clean stream in summer.

6. pH.

   a. A net decrease of 1.1 pH units from the lake to Dresden Island Pool, caused principally by organic decomposition.

7. Biochemical Oxygen Demand.

   a. A high average, 5-day, 20°C value of 11.1 mg/1 below the West-Southwest Sewage Treatment Works.
   b. Repeated reversals of natural downward trends in BOD, resulting from the discharges of both identified and unidentified waste sources.

8. Dissolved Oxygen.

   a. A net reduction of 11.5 mg/l from the Wilmette Control Works to Lockport Pool.
   b. An average of 0.6 mg/l in the Lockport Pool.
   c. Several individual values of zero in the Chicago Sanitary and Ship Canal above the confluence with the Calumet-Sag Channel.
   d. Twenty-six miles of the 69-mile Main Channel from Wilmette to Dresden Island Dam with average concentrations below 5 mg/1, which is a generally accepted minimum permissible limit.

9. Coliform bacteria.

   a. Concentrations exceeding 100,000 per 100 ml for 50 miles along the Main Channel, and exceeding 500,000 per 100 ml for nearly 40 miles, including the heart of downtown Chicago.
   b. A peak concentration, just above the West-Southwest Sewage Treatment Works, of 870,000 per 100 ml, which is 156 times the generally accepted permissible limit of 5,000 per 100 ml.
   c. Essentially the entire waterway down to Dresden Island Pool, with the exception of very short distances immediately below the three points of lake water diversion, with concentrations in excess of the generally accepted maximum of 5,000 per 100 ml.

The causes of this extremely excessive pollution are the sewage treatment plant effluents, the regular direct discharge to the waterway of untreated or partially treated wastes, intermittent storm water overflows, and bypassing of untreated sewage during periods of high sewage flows.

The pollution pattern of the Illinois Waterway differs in one important aspect from the pattern in the majority of polluted streams of the Nation. In such situations, the municipality or industry causing the pollution suffers little or no damage from its own wastes. Downstream communities and other water users bear most of the burden of damages resulting from upstream waste discharges.

Pollution of the Illinois Waterway inflicts its greatest damage on the Greater Chicago Area. Most of the worst effects of pollution appear in the waterway as it flows through the heart of this city of five and one-half million people. In this situation, expenditures for improved waste disposal by Chicago will benefit Chicago itself, even more than it will downstream communities.

This relationship of benefits from improved waste disposal by Chicago may not continue indefinitely into the future. As downstream communities and industries grow and expand, their water supply requirements may increase to the point where only the large flow of the Illinois River will be sufficient to meet their water supply needs. When this stage of growth is reached, the Illinois Waterway below Chicago must be of a quality suitable to meet the highest priority use for any surface water, that of municipal water supply.

FLOW CONSIDERATIONS

Solicitor General J. Lee Rankin, on February 23, 1960, addressed a letter to Mr. Stein, Chief, Enforcement Branch, U. S. Public Health Service, regarding the Illinois Waterway. He requested that the waterway be studied to determine and present evidence on quality of water under several hypotheses.

Based on both the study of pollution of the waterway that has been completed to date, and on general experience and judgment, it is possible to provide quantitative data on water quality during the period of study, April 24 - May 21, 1961, and to furnish opinions, principally qualitative in nature, on certain other aspects of the hypothetical considerations. After there has been an opportunity to complete detailed analysis and interpretation of data assembled thus far it may be possible to supplement some of the qualitative opinions with quantitative estimates. Some of the hypotheses cannot be resolved quantitatively until field study has been extended through the hot summer months, and the natural purification characteristics of the waterway have been established.

The five hypotheses and opinions relating to them follow. It is well to emphasize that the Solicitor General's question did not involve consideration of the possible impact of the discharge of sewage effluent to Lake Michigan on the Chicago public water supply, and this possibly serious factor is not considered in the subsequent opinions.

> "1. Under present conditions of domestic pumpage from the Chicago metropolitan area and 1500 cubic feet per second direct diversion from Lake Michigan."

The water quality of the Illinois Waterway for the period April 24 - May 21, 1961, has been studied intensively, and the results of the study have been presented elsewhere in this report. Briefly, the results reveal that, on the basis of nearly every criterion commonly used to judge the effects of sewage pollution, the waterway in the Greater Chicago Area is one of the most seriously polluted major streams of this Nation. As serious as the pollution was during the April-May study, there is every reason to believe that conditions will be even worse in July and August when temperatures are higher.

> "2. Under conditions of continuation of present domestic pumpage but a reduction of direct diversion to 810 cubic feet per second."

Under present conditions of waste disposal but with lake diversion reduced to 810 cfs, the presently serious pollution of the waterway would be intensified in the Chicago area. With the reduced volume of flow, the velocity of flow of the water would be reduced. The resulting longer time of water travel and correspondingly longer time for natural purification to exert its effects possibly would result in minor improvement in water quality at points some distance downstream as, for example, Joliet, Illinois.

The reduction of direct diversion to 810 cfs could seriously reduce the benefit of diversion. It has been reported that an average of about 500 cfs of the present 1,500 cfs diversion is uncontrolable runoff from the drainage area formerly tributary to the lake, with an average of 1,000 cfs being drawn from the lake. This 500 cfs of runoff is of minimum benefit for dilution within the Chicago area, as has been noted under the discussion of "Hydraulic Characteristics." There is no control of such runoff in Chicago, and therefore it cannot be used most advantageously to apply to waterway reaches where pollution is the worst and dilution needs the greatest. Another disadvantage is that runoff occurs intermittently and therefore is not available for continuous application for dilution in the Chicago area. There are numerous storms each year which produce several times the average 500 cfs of runoff for days at a time and when increased flow is not needed in the waterway. When this occurs, it is necessary to make up for the temporary, greater than average, dilution by subsequently cutting diversion from the lake below the average annual 1,000 cfs, to meet the deficit caused by the uncontrolled intense runoff. At present, the diversion of 1,000 cfs of lake water permits some flexibility in meeting the irregularities in dilution resulting from the runoff. If direct diversion were reduced to 810 cfs, an average of only 310 cfs could be drawn directly from the lake, and much of the present flexibility in use of lake water would be lost.

"3. Under conditions of return of all domestic pumpage or sewage effluent from the Chicago Metropolitan Area to Lake Michigan and 810 cubic feet per second direct diversion."

Return of all present sewage effluent from the Chicago Metropolitan Area to Lake Michigan and continuation of 810 cfs of lake diversion would result in some improvement in water quality in the waterway. Problems of direct discharge to the waterway of untreated or partially treated sewage and industrial wastes, and intermittent overflows of highly polluted storm water carrying untreated sewage and industrial wastes would remain. The effects on water quality of present direct untreated waste discharges cannot yet be evaluated, but there is every reason to believe that the intermittent storm water overflows would cause serious intermittent pollution, especially of a visual and bacterial nature. Storm water overflow effects on dissolved oxygen of the waterway cannot be estimated without further study.

"4. Under conditions of return to Lake Michigan of sewage effluent except for 810 cubic feet per second of such effluent from Chicago Metropolitan Area and no direct diversion." .

This hypothesis is similar to "3" above, except that all direct diversion would be eliminated and instead of discharging all treated sewage to the lake, 810 cfs of the effluent would be discharged to the waterway. It is assumed that the 500 cfs of diversion attributable to uncontrolled storm runoff will continue to be tributary to the waterway. This is considered reasonable since the only method of returning this runoff would be to collect and pump, or to redirect the Chicago and Calumet Rivers back into the lake. There would be very little dilution of treated sewage except during periods of rainfall and runoff. During wet weather periods storm water overflows would continue to cause temporary increases in pollution as at present.

"5. Under the several conditions as to quantities stated in "1", "2", "3", and "4", but with conditions of treatment of effluent by the Metropolitan Sanitary District of Greater Chicago improved to the optimum extent possible under presently available methods."

This hypothesis duplicates the first four, except that it assumes conditions of treatment of effluent improved to the optimum extent possible. It is assumed in this report that the improvements would include separation of storm and sanitary sewers, treatment of the first flush of runoff following rainfall, expansion of existing plants as necessary, treatment of all presently untreated wastes, rapid sand or other filtration of biologically treated effluents, and chlorination of the final effluent. It should be noted, however, that this assumption is made in the absence of cost estimates which would indicate the economic feasibility of the assumed improvements.

(1) With the improved treatment assumed and continuation of the present 1,500 cfs direct diversion, there would be tremendous improvement in water quality of the waterway. Although quantitative estimates of water quality that would result cannot be made at present, it is probable that the quality would be such as generally would be considered acceptable.

(2) This hypothesis cannot be evaluated until natural purification characteristics of the waterway have been measured accurately.

(3) Under the conditions of improved treatment assumed, the flow in the waterway would be essentially unpolluted lake water of high quality. A minor exception to the generally high quality might exist in the vicinity of Calumet Harbor, where there may be pollution of the lake water entering the waterway by industries outside the Metropolitan Sanitary District which discharge wastes directly to the lake.

(4) Same as (2) above.

METHODS OF IMPROVING WATER QUALITY OF THE ILLINOIS WATERWAY

There are means by which the water quality of the waterway can be improved substantially. Quantitative estimates of the degree of improvement that can be achieved must await accurate measurement of the natural purification capacities of the waterway.

The following methods by which improved water quality can be achieved are discussed without regard to the costs involved. Recommendations that any or all of the methods be adopted would be premature in the absence of at least preliminary estimates of costs involved and of quantitative water quality improvements that can be achieved.

1. Separation of storm and sanitary sewers. As long as domestic sewage and industrial wastes are collected in the storm water collection system it will not be feasible to treat all sewage and industrial wastes all of the time. There will continue to be frequent periods following heavy rainfall and runoff, when large quantities of untreated wastes will discharge directly to the waterway. Following such discharges, the waterway will exhibit all of the visual evidences of pollution observed during the April 24 - May 21, 1961 study, concentrations of coliform bacteria will be dangerously high, sludge deposits will be produced, and dissolved oxygen content will be reduced or depleted. It is recognized fully that a sewer separation program would be extremely costly, and the construction involved would cause disruptions and inconveniences to the citizens of Chicago for several years. However, in the normal course of events, Chicago may be expected to remain a metropolis for hundreds of years. It is probable that at some time in the future, increased waste loads from increased population and industry will force separation of sewers to prevent or to cure an intolerable situation. The longer the separation is postponed the more costly and difficult it will become. The officials and citizens of Chicago should consider the benefits of a continuously clean waterway that will accrue during their lifetimes as well as to many future generations. Washington, D.C., has faced up to this problem and is committed to a sewer program which initially was estimated to cost $330,000,000.

2. Provisions for treatment of the first flush of runoff following rainfall. Even in the absence of sewage and industrial wastes, the first runoff following rainfall contains quantities of filth flushed from the surface areas of a metropolitan area. Without treatment this filth can seriously degrade water quality.

3. Collection for treatment in municipal plants, or treatment at the sources, of all sewage and industrial wastes now discharged directly to the waterway without treatment or with inadequate treatment.

4. Revision or expansion of existing sewage treatment plants to remedy any existing inadequacies, and to accommodate any increased waste loads that might result if suggestions 1 and 3 were adopted.

5. Rapid sand filtration or possibly mechanical microstraining of sewage treatment plant effluents. Preliminary data indicate that the fine floc which escapes the final sedimentation basins of the present activated sludge plants has a significant potential for production of sludge deposits, with accompanying high oxygen demands, in the waterway.

6. Chlorination of sewage treatment plant effluents. In spite of the high percentage reductions in coliform bacteria a-

chieved by the activated sludge process, the effluents of such plants contain hundreds of thousands of coliform bacteria per 100 ml. In the absence of manyfold dilution of the effluent by clean water in the receiving stream, chlorination is the only practical means of controlling the residual bacterial contamination with its accompanying health hazard. Chlorination also will accomplish additional reduction in BOD of the plant effluents.

7. Control of return cooling water temperatures. Heat added to the waterway by return cooling water reduces saturation levels of DO and speeds up rates of BOD exertion. Both of these factors contribute to greater reduction in DO of stream water.

8. Greater flexibility in the control of dilution by diversion of lake water specifically for improved water quality. Limitations on optimum use of diversion for water quality control are imposed both by the Supreme Court decision regarding diversion and by the multipurpose use of the waterway. The Supreme Court decreed that Chicago should not divert an annual average of more than 1,500 cfs in any calendar year. Chicago cannot carry forward to a subsequent dry year any credit for that quantity of water less than 1,500 cfs which might be accumulated by decreased diversion in a wet year. The limitations of this restriction are made even more severe by the requirement that runoff which formerly reached the lake, before the natural directions of flow of portions of the waterway were reversed, must be included in the allowable diversion. If Chicago were permitted to divert on the basis of an annual average diversion limit extended over a five to ten year period rather than over one year only, some of the disadvantages of this limitation could be overcome. Chicago has no authority over the water used for lockage on the Calumet-Sag System. As a result of navigation requirements, this System, on which is located the smallest of the Sanitary District's three major sewage treatment works, carries the largest single portion of the total diversion. If Chicago could have some measure of control over lockage requirements, a more advantageous division of dilution water among the three points of diversion could be achieved. In the interests of optimum water quality control it would be advantageous to use less water for dilution during cold winter months, and more during hot summer months.

9. Artificial aeration. Although artificial aeration by mechanical means has been attempted on a few relatively small streams, the accomplishments have not been impressive. There appears to be no valid technical reason, however, to doubt that properly designed aeration facilities could add appreciable quantities of DO to the waterway.

10. Return of treated sewage effluent to Lake Michigan. Although return of a portion or all of the treated sewage effluent to the lake would reduce the load of pollution on the waterway, the potential hazards of such a measure to Chicago's water supply and to recreational use of the lake require that this measure be approached, if considered, with extreme caution. A great deal of investigation is essential to obtain the data necessary for a sound evaluation of the very real public health hazards inherent in this suggestion.

11. Increased diversion of lake water. Provision of additional dilution through increased diversion of adequate quantities of lake water undoubtedly could improve water quality of the waterway. It is not possible, until natural purification rates of the waterway have been determined, to establish the quantity of diversion that would accomplish needed improvement in water quality.

Improvement in water quality of the Illinois Waterway will be costly. There is no simple, easy solution to the dilemma with which Chicago is faced. The best solution to the problem will require the combined intelligence of the best and most imaginative minds of the engineering profession, especially the sanitary engineer. But even the best minds cannot solve the problem without an adequate body of sound technical data as a starting point. To date the necessary data are not available. A start on collection of the needed data has been made, but a great deal more must be developed before all ramifications of this tremendously complex situation can be assayed soundly and irrefutably. The costs that will be involved in revisions of the waste collection and treatment system demand that every reasonable precaution be taken to assure that whatever changes ultimately are made will do what they are expected to accomplish.

CONCLUSIONS

1. The Great Lakes - Illinois River Basins encompass an area of vast economic, commercial and industrial importance; its potential is even greater.

2. Associated with growth will be the related increasing demands of municipal, industrial, and other water needs and concurrent waste disposal problems.

3. The three large sewage treatment works operated by the Metropolitan Sanitary District of Greater Chicago provided treatment of about 89 percent as measured by BOD reduction during the period of study.

4. Industrial wastes, both treated and untreated, are discharged to the waterway. Although the total amount may be relatively small as compared to the municipal wastes, further study is necessary to fully evaluate this condition.

5. The combined sewer system in Greater Chicago discharges wastes directly to the waterway when storm drainage plus municipal sewage exceeds the capacities of the interceptors and capacity of the sewage treatment plants. Further study and evaluation is needed to determine the amount of pollutants from these sources that reach the waterway.

6. Waste control measures in Greater Chicago, considering sewage, industrial waste, storm overflow and drainage, under existing flow and diversion regulation, are inadequate to prevent extreme pollution of the waterway as far downstream as the Brandon Road Pool.

7. Pollution in the waterway is evident as measured by visual observation and chemical, biochemical, bacteriological, biological and physical parameters. Extensive sludge deposits were detected and sampled biologically.

8. Reducing diversion flows, with existing sewage and waste control and treatment practices, will increase the pollutional effects on the waterway within the Greater Chicago Area.

9. More effective control and treatment of wastes, including both short and long range objectives, should consider: (a) separation of storm and sanitary sewers; (b) treatment of initial flush of debris and organic matter resulting from storm drainage; (c) discharge of all industrial wastes to municipal sewerage or comparable treatment by industry; (d) revisions or additions to existing plants to accommodate the added loads that will result from steps (a) and (c); (e) supplemental treatment of the effluent from sewage treatment works by straining devices, such as sand filtration or other means, to remove residual suspended matter, and; (f) chlorination of final effluents.

10. Regulation of diversion flows to provide maximum discharge during critical summer months and minimum flow during the cold season with carry-over privileges if allocated diversion is not used within a given year would permit maximum utilization of available dissolved oxygen resources.

11. Conclusions regarding utilization of Lake Michigan as the receiving waters for treated sewage will depend upon the results of studies of Lake Michigan currents which will determine the feasibility of locating sewer outfalls to minimize the effect of such wastes upon the municipal water supplies. This consideration should presuppose improved waste treatment, with chlorination of the effluents from treatment

plants. The possible impact of the wastes upon biological reactions and the build-up of stable waste constituents must be evaluated.

WATER RESOURCES

The water resources of the Great Lakes and Illinois River Drainage Basins are among the world's greatest. Nature has endowed this area with large surface water reserves and an enormous ground water reservoir in the permeable soil. Although there has been exploitation of the natural resources within the Basin, there are still great opportunities for continued development as an industrial and recreational area.

SURFACE WATER

Lake Michigan has a water surface area of about 22,400 square miles ,and a maximum depth of 924 feet. The lake is connected with Lake Huron by the broad and deep Straits of Mackinac. There may be appreciable currents in either direction through the Straits because of winds or differential barometric pressures over the surfaces of the two lakes; but on the average, there is a movement of water from Lake Michigan to Lake Huron which the North Central Division, Corps of Engineers, United States Army, has estimated to be on the order of 48,000 cubic feet per second. The slope required for this average movement of water is imperceptible and, in terms of monthly mean elevation, the two lakes stand at virtually the same level. The average water surface elevation of the two lakes is about 580 feet above mean tide at New York City. The average annual variation in levels of Lake Michigan is about 1.1 feet. The seasonal high usually occurs in July and the seasonal low usually is reached in February.

The average annual rainfall over the Lake Michigan Basin is about 31 inches, and is well distributed throughout the year. The streams of the Basin receive a large portion of their total flow from ground water and outflow from the numerous natural lakes which dot the area. The runoff of these watersheds is generally from ten to fifteen inches per year and is reasonably uniform. The streams have generally uniform slopes with few abrupt falls. Table 1 gives drainage area, average annual runoff, and maximum, minimum, and average flows during years of record for United States Geological Survey gaging stations on the major streams tributary to Lake Michigan.

The natural drainage area of the Illinois River was about 28,200 square miles. Reversal of flow of the Chicago and Calumet Rivers and interception of certain drainage areas along the lake shore has added about 810 square miles to the Illinois River watershed, making an existing total of 29,010 square miles. The eastern portion of the Little Calumet River watershed, amounting to 335 square miles, was diverted into Lake Michigan through Burns Waterway in 1926 and is not included in the preceding totals.

The average annual rainfall over the Illinois River Basin is about 34.5 inches well distributed throughout the year, usually somewhat greater in the southern than in the northern portion of the Basin. However, the Basin is subject to extended drought periods, as well as extreme floods. The latter usually result from prolonged heavy rainfall during December through June. With normal rainfall conditions, the flat rolling topography, together with high proportion of land under cultivation, tends to retard runoff. The average annual runoff over the Basin is about eight inches. Table 2 shows average annual runoff at United States Geological Survey stream gaging stations on major tributaries of the Illinois River. Annual runoff is not shown for the main stem because flows include diversion from the Lake Michigan watershed.

The discharge of the Illinois River at Meredosia, Illinois, (drainage area 25,300 square miles) varies between about 3,000 and 120,000 cubic feet per second, and has averaged about 20,000 during 21 years of record through 1959. At Marseilles, Illinois,

TABLE 1
LAKE MICHIGAN BASIN STREAM FLOW DATA

Stream and Location	Years of Records (a)	Drainage Area Sq. Miles	Average Annual Runoff, In.	Discharge, cfs		
				Maximum	Minimum	Average
Manistique R. nr. Manistique, Michigan	21	1,100	16.43	15,400	288	1,318
Escanaba R. at Cornell, Michigan	18	870	14.37	10,000	90	927
Menominee R. nr. McAllister, Wisconsin	14	4,020	11.82	25,700	538	3,229
Peshtigo R. at Peshtigo, Wisconsin	6	1,124	8.65	4,400	32	726
Fox R. at Rapide Croche Dam, nr. Wrightstown, Wisconsin	63	6,150	7.81	24,000	138	4,135
Milwaukee R. at Milwaukee, Wisconsin	45	686	7.80	15,100	0	381
St. Joseph R. at Niles, Michigan	29	3,620	11.69	20,200	420	3,114
Kalamazoo R. nr. Fennville, Michigan	29	1,600	11.80	17,500	73	1,335
Grand R. at Grand Rapids, Michigan	33	4,900	9.76	54,000	381	3,498
Muskegon R. at Newaygo, Michigan	37	1,902	11.19	14,950	330	1,902
Pere Marquette R. at Scottville, Michigan	20	709	11.67	2,740	310	609
Manistee R. nr. Manistee, Michigan	7	1,780	14.88	6,800	1,040	1,930

(a) Through 1959 Water Year

TABLE 2
ILLINOIS RIVER BASIN AVERAGE ANNUAL RUNOFF

Stream and Location	Average Annual Runoff, Inches
Des Plaines R. at Riverside, Ill.	7.57
Kankakee R. nr. Wilmington, Ill.	9.88
Fox R. at Dayton, Ill.	7.78
Vermilion R. at Lowell, Ill.	8.30
Mackinaw R. at Green Valley, Ill.	8.63
Spoon R. at Seville, Ill.	8.25
Sangamon R. nr. Oakford, Ill.	7.85
LaMoine R. at Ripley, Ill.	7.45

(drainage area 7,640 square miles) the discharge has varied between about 1,500 and 94,000 cubic feet per second, with an average of about 11,000 during the period 1919-1959.

The Des Plaines River rises in southeastern Wisconsin and flows in a southerly and southwesterly direction about 110 miles to the junction with the Kankakee River. Between the north edge of Joliet and the Kankakee River, about 17 miles, it forms a part of the Illinois Waterway with a navigable channel at least nine feet deep and 300 feet wide. The Brandon Road Lock and Dam, with a lift of about 34 feet, is located at Joliet. The natural drainage area of the Des Plaines River is about 1,370 square miles. The Chicago Sanitary and Ship Canal joins the Des Plaines at Joliet, adding some 810 square miles from the Lake Michigan watershed, making a total of 2,180 square miles. The discharge at Riverside, Illinois, (drainage area 635 square miles) has varied between about 1 and 6,500 cubic feet per second, with an average of about 350, during the period of record 1943-1959.

Discharge records for the Chicago Sanitary and Ship Canal at Lockport, Illinois, have been maintained by the Chicago Metropolitan Sanitary District since 1900. The flow at Lockport includes return flows from pumpage, diversion from Lake Michigan, and natural drainage. Flows have varied between about 90 and 24,500 cubic feet per second, with an average of about 6,000 for the 59 years through 1959. However, since the diversion from Lake Michigan was reduced to an annual average of 1,500 cubic feet per second December 31, 1938, the flow at Lockport has averaged about 3,500 cubic feet per second.

The source of the Kankakee River is near South Bend, Indiana. From this point the river flows southwesterly to Kankakee, Illinois, and thence northwesterly to its confluence with the Des Plaines River, a total distance of some 130 miles. The drainage area is about 5,280 square miles. Discharge records collected near Wilmington, Illinois, (5,250 square miles) indicate a range of discharge between 200 and 75,900 cubic feet per second, with an average of about 3,840 during the period 1933-1959.

Table 3 shows length of record, drainage area, maximum, minimum, and average flows, and minimum average monthly flow expectancies, for United States Geological Survey gaging stations on Illinois River and major tributaries.

GROUND WATER

Ground water sources in the northeastern Illinois area are widely variant in quality. There are approximately 3,000 wells, most of

TABLE 3
ILLINOIS RIVER BASIN STREAM FLOW DATA

Stream and Location (1)	Years of Record(a) (2)	Drainage Area Sq. Mile (3)	Discharge, cfs			Minimum Mean Monthly Flow(b) cfs That May Be Expected Once In		
			Maximum (4)	Minimum (5)	Average (6)	2 Years (7)	5 Years (8)	10 Years (9)
Kankakee R. at Shelby, Ind.	37	1,753	7,200	260	1,518	846	598	455
Iroquois R. nr. Chebanse, Ill.	36	2,120	27,000	9	1,562	215	85.5	45.4
Kankakee R. nr. Wilmington, Ill.	26	5,250	75,900	204	3,836	1,139	763	527
Des Plaines R. at Riverside	16	635	6,510	0.4	349	27.8	22.2	4.27
Chicago Sanitary & Ship Canal at Lockport, Ill.	59	810	24,580	91	5,966	2,996	2,707	2,296
Du Page R. at Troy, Ill.	19	325	12,000	0.2	215	44.4	34	27.4
Mazon R. nr. Coal City, Ill.	20	470	17,600	0	301	5.47	1.11	0.17
Illinois R. at Marseilles, Ill.	40	7,640	93,900	1,460	11,110	5,097	4,514	3,993
Fox R. at Wilmot, Wisc.	20	880	5,400	35	420	150	112	89.6
Fox R. at Dayton, Ill.	44	2,570	47,100	78	1,467	438	283	239
Vermilion R. at Lowell, Ill.	28	1,230	33,500	5.9	749	30.7	21.4	8.82
Mackinaw R. nr. Green Valley, Ill.	35(c)	1,100	31,000	17	688	87	62.9	41.1
Illinois R. at Kingston Mines,Ill.	20	15,200	83,100	2,300	13,690	5,505	5,233	4,196
Spoon R. at Seville, Ill.	45	1,600	37,300	3.8	963	111	89	30.4
Sangamon R. at Riverton, Ill.	46(c)	2,560	68,700	3.0	1,692	227	76.1	33.6
Sangamon R. nr. Oakford, Ill.	32	5,120	123,000	68	2,989	543	365	200
LaMoine R. at Ripley, Ill.	38	1,310	17,100	4.9	719	87.8	35.3	12.7
Illinois R. at Meredosia, Ill.	21	25,300	123,000	3,060	19,960	6,938	6,283	4,915
Macoupin Cr. nr. Kane, Ill.	31	875	40,000	0	546	25.5	11.6	2.49

(a) Through 1959 Water Year
(b) Months of July-October for Period of Record Through 1956
(c) Station Discontinued October 1956

TABLE 4
AVERAGE WELL WATER CHARACTERISTICS (a)

Classification of Wells by Aquifer	Range of Depth (Feet)	Hardness (ppm)	Temperature (°F)	Iron (ppm)	Chloride (ppm)	Sulfate (ppm)	Total Minerals (ppm)
Drift or Limestone	Less Than 600 Feet	400-1200	55-60	0.3 or more in 80%	5-10	High	-
St. Peter Sandstone	630-1380	225-500	60-64	-	35-300	100-450	540-900
Galesville	1400-1850	300-600	64-67	-	-	100-450	800-1500
Mt. Simon	1900-2756	300-800	67-70	0-3.0	100-800	-	-

(a) From "Ground Water Supplies of the Chicago-Joliet-Chicago Heights Area," Bulletin No. 35, Illinois State Water Survey, 1943.

which are drift or limestone wells. There are small numbers of deep wells ranging from 600 to 2,800 feet. Of all known wells in this area, about 87% are private, 3% are municipal and 10% are industrial. The total daily pumpage from these wells is approximately 75 million gallons.

The quality of well water varies according to the several aquifers. Table 4 summarizes briefly several of the more important characteristics of these well supplies. The raw water turbidity varies, but is less than 10 units most of the time and less than 5 units at least 50% of the time.

A very significant factor is the decline of artesian pressure related to the lowering of the water table throughout this entire area. It is a matter of record that at Chicago, the artesian pressure has declined by 660 feet from 1864 to 1958, an average of 7.1 feet per year, and in recent years the decline has been about 10 feet per year due to progressive increases in pumpage. Declines in pressure of similar magnitude have been experienced in most other localities in the Chicago Metropolitan Area. One instance has been reported in the Joliet area of a decline of as much as 50 feet in one year. This problem is serious for many communities as not only does it reduce available quantities but also affects quality.

This problem is progressive and points to necessity in the near future of many communities searching for alternate sources of supply, probably surface sources.

USE OF WATER RESOURCES

The water resources of the region are used for sources of domestic and municipal supplies, industrial processing and cooling water, removal and ultimate disposal of treated and untreated municipal and industrial wastes, navigation, game and commercial fishing, recreation, limited irrigation, hydro- and thermal-electric power, livestock watering, and support of wildlife. Shortages have occurred at some locations, particularly during drought periods.

MUNICIPAL WATER SUPPLIES

An inventory of municipal and semipublic water supplies in the Upper Illinois River Watershed above the Kankakee River junction has been compiled as Appendix IV. The listings include incorporated and unincorporated communities, subdivisions, institutions and commercial establishments such as motels. A summary of the data is contained in Table 5.

Surface Water Supplies

The bulk of the municipal water served to the Upper Illinois River watershed communities is derived from Lake Michigan through the systems of Chicago, Evanston, Wilmette, Skokie, Winnetka, Glencoe, Highland Park, Hammond, Gary-Hobart, Highwood and the Great Lakes Naval Training Station. In some cases the supply is delivered through an intermediate community. There are no known municipal water supplies taken from streams or waterways of this region. All water from Lake Michigan is filtered and disinfected with the exception of the north portion of the Chicago system which is disinfected but not filtered. A filtration plant is under construction.

In this watershed, Lake Michigan serves an estimated 4,929,000 persons with an estimated 1,123.8 MGD or 228 gallons per capita per day. These represent 87.2% and 94.6% respectively of the persons served and volume of water supplied in this area from both surface and ground water sources.

Ground Water Supplies

Some 725,000 persons are supplied an estimated 64.0 MGD from subsurface sources or about 88 gallons per capita per day. These represent 12.8% and 5.4% respectively of the persons served and the volume of water supplied in this watershed from both surface and ground water.

INDUSTRIAL WATER SUPPLIES

Industrial establishments in the Illinois Basin obtain their water resources by three means: direct purchasing from public or private water supply, from wells, if the ground water situation is favorable, or from adjacent surface sources.

Surface water sources provide the bulk of the water used by industry in the Basin. In 1959, 1.37 billion gallons per day were consumed for manufacturing and processing. Industries that use surface waters in the Basin are: steel and other metals, mining and quarrying, oil refining, chemicals, cement, beverage and food processing, paper and paper products, and railroads. Use of water for power will be discussed later.

About one billion gallons a day of surface waters are used for manufacturing and processing by industries located in the Upper Illinois River Waterway. The Chicago Sanitary and Ship Canal provides 184.20 MGD to industry. Oil refineries located along the Canal use 123.63 MGD; the balance is distributed among manufacturing, steel and other metals, and chemical industries. The Calumet River supplies 670.23 MGD to industry. About 98% of this water is used by the steel and other metals industry, and the remaining water is used by manufacturing and chemical industries.

Table 6 indicates the average surface water pumpage from private intakes for the year 1959 in the Upper Illinois Waterway Basin as reported in Volume XXII, Proceedings of the American Power Conference.

About 43 million gallons per day of ground water is used by industries located in Cook, Du Page, Lake and Will Counties as shown in Table 7.

NAVIGATION

The Illinois Waterway provides a navigation channel with a minimum depth of about 21 feet from the Chicago Harbor at Lake Michigan, to the Chicago River at Lake Street. From the Chicago River at Lake Street to the confluence with the Mississippi River at Grafton, Illinois, a channel with a minimum depth of nine feet is provided. These channels are controlled by means of a series of seven locks and dams operated by the Corps of Engineers.

At Chicago, the waterway has two means of access for commerce to Lake Michigan, one at the mouth of the Chicago River and the other at the mouth of the Calumet River. Table 8 shows the locations of the seven locks and the estimated shipping capacity of each lock on the Illinois Waterway.

The Illinois Waterway, in addition to serving Chicago and nearby industrial areas in Indiana, also serves several important manufacturing cities along its route including Joliet, Ottawa, La Salle and Peoria. It traverses an agricultural area and is adjacent to important coal fields. Freight commerce on the waterway has increased since the improved channel to Chicago was opened, from 1,695,000 tons in 1935 to 23,377,000 tons in 1956. The principal commodities were coal, petroleum products, sand, gravel, stone, grain, sulphur and iron and steel products.

At present the Corps of Engineers is planning a system of duplicate locks for the Illinois Waterway. The seven duplicate locks proposed in the "Plan of Improvement" will be 110 feet wide and 1,200 feet long as compared with existing locks that have a width of 110 feet and a length of 600 feet. Also under consideration is the enlargement of the waterway to provide a 12 foot depth navigation channel from the Chicago River at Lake Street to the mouth of the Illinois River at Grafton, Illinois.

Studies by the Corps have indicated that the supplementary locks would accommodate a predicted traffic below Lockport of 55,000,000 tons by the year 2000. The Corps estimates that an average annual flow of about 1,826 cubic feet per second would provide the water requirements for the modified Illinois Waterway at such time as the traffic contemplated develops.

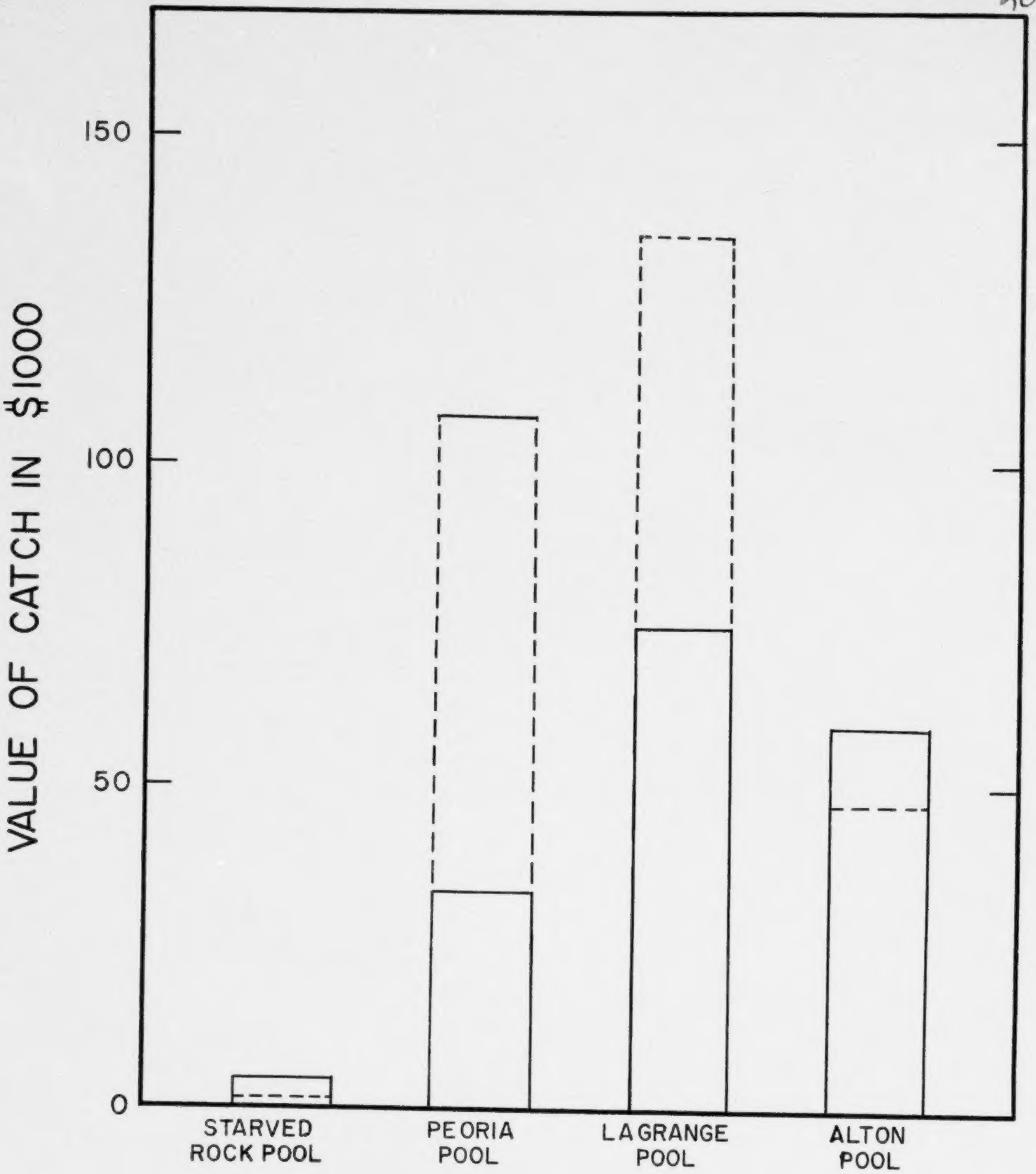
The Metropolitan Sanitary District of Greater Chicago reported the 1959 average annual diversion from the Lake Michigan watershed as 1,487 cubic feet per second, in addition to 1,803 cfs domestic pumpage and 310 cfs Des Plaines River inflow.

FISH AND WILDLIFE

Commercial fishing in the Illinois River for the year 1960 was limited to the stretch from Ottawa and vicinity in Starved Rock Pool to the confluence with the Mississippi River at Grafton. Above Ottawa, the fish quality makes the catch unsuitable for the commercial market. Downstream pools surveyed by the Illinois Natural History Survey for commercial fishery statistics are designated as: Starved Rock Pool, Peoria Pool, La Grange Pool, and Alton Pool (Figure 3).

In the Starved Rock Pool, most of the commercial fishing is done in the vicinity of Ottawa. The commercial catch from this pool in 1960 was 25,000 pounds valued at $4,500; in 1950 10,000 pounds valued at $700. The marketed catches included carp, buffalo, drum, catfish, bullhead and sucker.

There is some commercial fishing in the upper reach of the Peoria Pool in Lake De Pue although most of the commercial fishing takes place at Lake Senachwine near Putnam. The catch from this pool in 1960 had decreased to 471,000 pounds valued at $33,500 from 2,790,000 pounds valued at $ 106,000 in 1950. Marketed fish were carp, buffalo, drum, bullhead and paddlefish.



ILLINOIS RIVER COMMERCIAL FISHING *
1950 & 1960

LEGEND

* FROM ILLINOIS NATURAL HISTORY SURVEY

---- REPRESENT 1950 VALUES

—— REPRESENT 1960 VALUES

FIGURE 3

20-a

	Miles above Grafton	Pool Elevation at Locks Ft. above M.S.L. Lower	Pool Elevation at Locks Ft. above M.S.L. Upper
Chicago River (at Lake Michigan)	327.0	579.0	—
Chicago Sanitary & Ship Canal (at entrance to Chicago River)	321.1	—	—
Calumet-Sag Channel (junction with)	303.5	—	—
Lockport Lock	291.0	539.0	578.5
Desplaines River (at entrance to Chicago Sanitary & Ship Canal)	290.0	—	—
Brandon Road Lock & Dam	286.0	505.0	539.0
Du Page River (mouth of)	277.0	—	—
Kankakee River (mouth of)	273.0	—	—
Dresden Island Lock & Dam	271.5	483.25	505.0
Mazon River (mouth of)	263.5	—	—
Marseilles Dam	247.0	—	—
Marseilles Lock	244.6	459.0	483.25
Fox River (mouth of)	240.0	—	—
Starved Rock Lock & Dam	231.0	440.0	459.0
Peoria Lock & Dam	157.7	429.0	440.0
La Grange Lock & Dam	80.2	419.0	429.0
Mississippi River – Illinois River junction at Grafton, Illinois	0.0	—	418.0

FIGURE 4

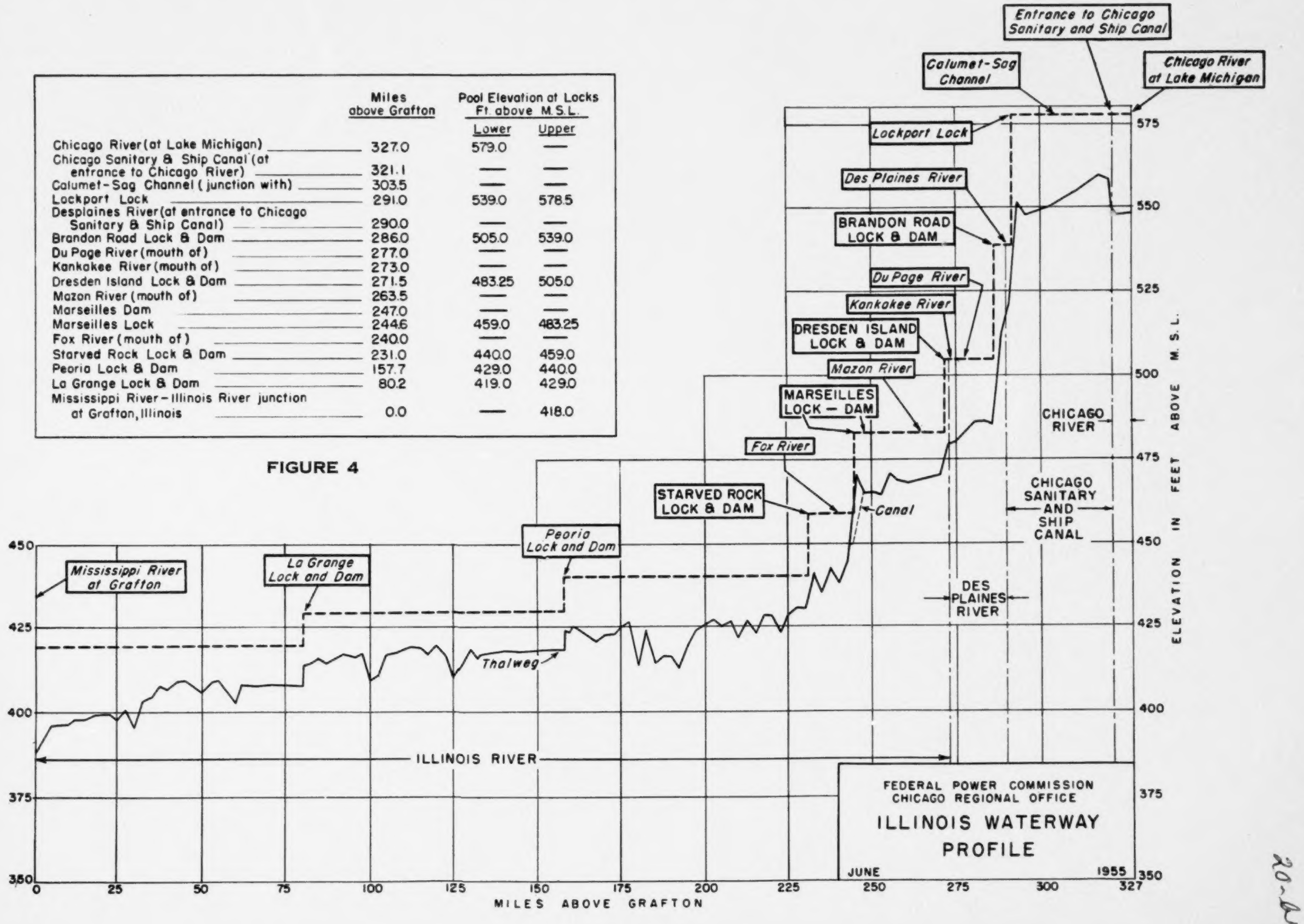


TABLE 5
WATER SUPPLIES DATA-SUMMARY

Major Basin Illinois Waterway	State Illinois & Indiana	County All Counties in Upper Illinois Waterway				
Subbasin: All Five subbasins in Upper Illinois Waterway						
Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
Totals for Subbasins & Counties						
North Branch Chicago River (1) Lake and Cook Co.	Wells and Lake Mich.	3,924,385	-	3,941,987 (1)	971.258 (1)	
Calumet & Sag Channel Cook & Will Co. Illinois Lake Co. Indiana	Wells and Lake Michigan	653,311	-	620,751	82.676	
Illinois Waterway Lake Michigan to Kankakee R. Cook & Will Co.	Wells and Lake Michigan	224,016	-	225,101	37.679	
Du Page River Cook, Du Page and Will Counties	Wells	124,468	-	112,911	8.295	
Des Plaines River Cook, Du Page, Lake and Will Counties	Wells and Lake Michigan	798,012	-	753,424	90.207	
Totals		5,724,192	-	5,654,174	1,190.115	

(1) Figures include all of Chicago and suburban non-municipal users served from Chicago Water Works (lumped under the North Branch Chicago River Subbasin for convenience) plus the suburban municipalities in this basin served by the Chicago Water Works plus municipalities along Lake Michigan which discharge sewage to the North Side (MSD) treatment plant in the Subbasin. Altogether, the Chicago Water Works serves an estimated population of 4,373,000 with a total usage estimated at 1,028.0 M.G.D.

TABLE 6
INDUSTRIAL WATER SUPPLIES - SURFACE SOURCES
INDUSTRIAL WATER SUPPLIES (ILLINOIS INDUSTRIES) (a)
UPPER ILLINOIS WATERWAY BASIN STREAMS, LAKES AND WATERWAYS

Number Plants	Type Industries	Source of Supply	Average Pumpage-MGD (b)
1	Chemical	Des Plaines River	3.46
1	Quarry	East Branch, Du Page River	2.64
4	Chemical	Chicago River and Branches	44.33
21	Metal, Chemicals and Other Mfg.	Calumet River	670.23
2	Metal and Chemical	Grand Calumet River	2.96
2	Metal and Other Mfg.	Calumet - Sag Channel	83.28
4	Metal, Oil Refinery, Chemical and Other Mfg.	Chicago Sanitary and Ship Canal	184.20
2	Metal, Other Mfg.	Lake Calumet	1.33
			992.43

(a) Private industrial supplies, exclusive of any waters supplied through community systems, such as Chicago and other Lake Michigan communities.

(b) Industrial manufacturing and processing pumpage.

TABLE 7
INDUSTRIAL WATER SUPPLIES - GROUND SOURCES
INDUSTRIAL WATER SUPPLIES (ILLINOIS INDUSTRIES) (a)
GROUND SOURCES IN COOK, DU PAGE, LAKE AND WILL COUNTIES, ILLINOIS

County	Number Plants	Type Industries	Source of Supply Shallow Wells	Deep Wells	Average Pumpage-MGD
Cook	148	Chemical, Food, Metal, Misc.	3.11	20.12	23.23
Du Page	100	Chemical, Food, Metal, Misc.	4.40	0.95	5.35
Lake	31	Chemical, Food, Metal, Misc.	1.51	0.65	2.16
Will	29	Chemical, Food, Metal, Misc.	0.07	12.53	12.60
			9.09	34.25	43.34

(a) Private industrial supplies, exclusive of any water supplied through community systems.

TABLE 8
NAVIGATION CAPACITY OF ILLINOIS WATERWAY
BELOW LOCKPORT (a)

Existing Locks	Capacity of Illinois Waterway Below Lockport (Tons Annually)	Date When Commerce On The Illinois Waterway Below Lockport Will Reach Capacity
Lockport	29, 800, 000	1968
Brandon Road	29, 800, 000	1968
Marseilles	32, 600, 000	1970
Dresden Island	34, 200 000	1972
Starved Rock	39, 700, 000	1977
Peoria	39, 700, 000	1977
La Grange	39, 700, 000	1977

(a) From the "Interim Report on Duplicate Locks, Illinois Waterway." Corps of Engineers, Chicago District; January 25, 1957.

The commercial catch from the La Grange Pool in 1960 had decreased to 990,000 pounds valued at $76,000 from 2,300,000 pounds valued at $136,500 in 1950. The catch included carp, buffalo, drum, catfish, bullhead, crappie, paddlefish, white carp and bowfin.

In the Alton Pool, the 1960 catch had increased to 636,000 pounds valued at $60,000 from 528,000 pounds valued at $48,500 in 1950. Fish taken from this pool showed a greater variety of species than in the upstream pools, and were as follows: carp,buffalo, drum, catfish, bullhead, shovelnose sturgeon, crappie, white carp, paddlefish, sucker, gar, bowfin and eel.

The total poundage of commercial fish caught in the Illinois River in 1960 had decreased to 2,122,00 pounds valued at $174,000 from 5,600,000 pounds valued at $335,500 in 1950. Cash values of the reported commercial fish are based on undressed weights and average wholesale prices. In 1950, 106 persons earned their entire living by fishing and 169 persons as a part-time livelihood. By 1960, this decreased to 69 full-time and 73 part-time fishermen. The lower level of commercial fishing activity reflects a multiplicity of causes including economic opportunities, available supply as influenced by species, and market demands, among other factors.

Commercial fishing in Lake Michigan has declined steadily. This decrease has been attributed by the Fish and Wildlife Service to the sea lamprey. This fish, with its parasitic habit, reduced the commercial catch of lake trout from 6,500,000 pounds in 1944 to 400 pounds in 1953, and also reduced the white fish to a very limited stock as well as affecting the catch of other marketable fish.

According to the Illinois Division of Fisheries there were eight Lake Michigan commercial fishing concerns in Illinois in 1960, three of which were based in Waukegan and the remaining five in Chicago. The 1959 annual catch was reported as 244,877 pounds of which 239,853 pounds were perch and chubs; the remainder were lake herring, alewives and smelt.

Sport fishing in the Illinois River Basin is done primarily at lakes, although there is some activity on the Illinois River. Shortly after the turn of the century, a number of flood-plain, bottomland lakes were drained and the areas incorporated into drainage districts for agricultural purposes. Some of the lakes that were not drained, or those that were drained and restored, offer the angler good sport fishing opportunities. These shallow, fertile lakes provide spawning ground, food, and habitat for large populations of large-mouth black bass, crappies, blue-gills, yellow perch, and other sport fish.

In 1950, a survey by the Illinois Department of Conservation revealed that eight drainage and levee districts along the Illinois River from Hennepin to Grafton might be available for acquisition and early development as potential conservation areas. These resort lakes, covering some 52,000 acres, would increase the availability of sport fishing areas of the Basin.

By 1957 only four drainage districts had been reflooded. Three of these are operated and managed as privately owned duck shooting clubs and the fourth, Lake Chautauqua, is a government controlled wildlife refuge.

A creel census of sport fishery made at Lake Chautauqua (near Havana) revealed the following statistics: fish caught by pole and line - 9,500 pounds in 1953 and 36,500 pounds in 1954. In 1954, 9,800 fish were caught on trotlines by 1,830 fishermen; calculated annual yield values were $2,500 in 1953 and $12,500 in 1954. The calculated average annual recreational value (cost of fishing, which included tackle, boats, transportation, etc.) in 1954 was $58,500.

In recent years, the waterfowl population has been reduced considerably in the Lake Chautauqua area. The reduction in numbers of waterfowl may be due to general reduction of birds in the Mississippi Flyway and possibly to a decline in the population of mollusca (small snails) which are an important food for these birds.

RECREATION

The Illinois Waterway Drainage Area has vast, well developed, water resources that attract millions of aquatic-recreationally-minded, persons each year. That section of the Basin extending into southern Wisconsin has numerous lakes providing excellent bathing, fishing, skiing and boating waters. Throughout the entire region are areas of magnificent scenic beauty and localities of unusual historic interest as State parks, memorials, conservation areas, and forest preserves. In the Basin, there are 14 State parks, eight State conservation areas, one State forest preserve, and seven County forest preserves.

The Basin provides 62,000 acres of water in ponds, sloughs, and shallow, flood-plain, backwater lakes which largely flank the river channel between Spring Valley and Meredosia. These lakes are used for public fishing, boating and swimming, as well as forming the heart of the duck habitat. The river valley provides some of the best mallard shooting in the Nation and over 300 private hunting clubs and most of the State-managed public hunting grounds are located here.

In the Cook County Forest Preserve District, along the confines of the Des Plaines River, North Branch Chicago River, Skokie River, and lagoons, there are numerous parks and forest preserves that attract persons from the Metropolitan Chicago Area. Chicagoans use these playgrounds for picnicking, boating, water skiing and angling. These tributaries are intensively fished, the catch consisting of rough fish such as carp, bullheads and suckers. Swimming in these waters has been discontinued for more than ten years. The vast lake frontage which provides complete aquatic recreation attracts numerous people to beaches, harbors and other waterfronts in the Metropolitan Chicago Area.

The waterway between the Chicago Harbor at Lake Michigan and Joliet is also used for aquatic recreation. Pleasure craft are frequently seen traveling along the canal system. Lockages of pleasure craft during 1960 for the seven locks along the Illinois River, reported to the Corps of Engineers, are as follows: upbound 7,889, downbound 8,586. In spite of hazards attributable to polluted waters children have been observed swimming in the canal and water skiers seen sporting in the waterway.

IRRIGATION

That portion of the Illinois Drainage Basin lying above the confluence of the Kankakee River has an average annual rainfall of 33 to

TABLE 9
EXISTING HYDROELECTRIC PLANTS ON OR NEAR ILLINOIS WATERWAY

Owner	Plant Name	Installed Capacity kw	Approximate Head-Ft.	Stream
Metropolitan Sanitary District of Greater Chicago	Lockport	19, 900	39	Chicago Sanitary & Ship Canal
Illinois Power Co.	Marseilles	2, 024	14	Illinois R.
National Biscuit Co.	Marseilles	450	15	Illinois R.
North Counties Hydroelectric Co.	Dayton	3, 680	30	Fox River

34.5 inches, while the lower portion of the Basin has an average annual rainfall of 33 to 36.7 inches. Fifty-four to 64% of the annual rainfall occurs during the crop growing season.

Seasonal abundance and timeliness of rainfall, water holding capacity of most soil, and the cost of irrigation versus crop returns are reasons that irrigation is not an important practice in Illinois. In 1960 an estimated 2,500 acres, or about 0.01% of cropland in the Illinois Basin were irrigated, primarily by well water. The economics of supplemental irrigation in Illinois indicate that irrigation is not expected to increase substantially during the next 10 to 15 years.

Based on information available for 1956, the largest concentration of irrigators was in the Chicago - Kankakee area, which included Cook, Will, and Kankakee Counties. Flowers, nursery, and vegetables were the chief crops irrigated. In the lower portion of the Illinois Basin, in Pike, Adams, Hancock, and Henderson Counties, the majority of the irrigators were grain and livestock farmers. Field crops were the chief crops irrigated in an area along the Illinois River from Peoria south, in Peoria, Tazwell, Fulton and Mason Counties.

POWER*

Use of water for hydroelectric power production in the Illinois River Basin is limited. The area drained by the Illinois River consists essentially of flat or mildly rolling farm land. The river, dropping 161 feet in the 327 miles from Lake Michigan to the Mississippi River, has few potential hydroelectric sites.

Figure 4 depicts the profile of the Illinois Waterway showing location of the various locks and dams. Table 9 tabulates existing hydroelectric plants. A list of proposed hydroelectric plants at existing locks and dams is contained in Table 10. Data on steam-electric plants are given in Table 11.

The utilities are not required to report the consumptive water uses (either source or amount), such as boiler feedwater make-up, etc. in their regular reports. However, they are interested in holding such uses to a minimum due to the cost of chemical treatment required to make the water acceptable for the particular use.

The combined water requirement capacities of the steam-electric plants along the Illinois Waterway system in the Chicago Metropolitan Area require that the flow in the system be used

---

* From Chicago Regional Office-Federal Power Commission Reference 4.

TABLE 10
PROPOSED HYDROELECTRIC PLANTS AT EXISTING LOCKS AND DAMS

Site Name	Proposed Capacity - kw	Approximate Head - Feet	Stream	Approximate Benefit[(a)] Cost Ratio
Brandon Road	13,000	33.6	Des Plaines River	1.5
Dresden Island	12,000	19.5	Illinois River	1.3
Marseilles	11,000	24.2	Illinois River	1.4
Starved Rock	12,000	18.6	Illinois River	1.15

(a) The costs are based on Chicago Regional Office preliminary studies of incremental costs of powerhouse and associated equipment, and transmission lines necessary to interconnect to the nearest utility. Excludes any allocation of cost of the existing dams associated with the locks. The benefits are based upon the following power values:

Capacity value --------------- $/kw/yr. --------------- 26.00
Energy value----------------- Mills/kwh--------------- 2.60
Taxes foregone--------------- $/kw/yr. --------------- 10.60

The above values were calculated assuming the most likely alternate source to be a large, modern, privately financed steam-electric plant, of the type now being constructed in the upper Illinois area.

several times over as cooling water.

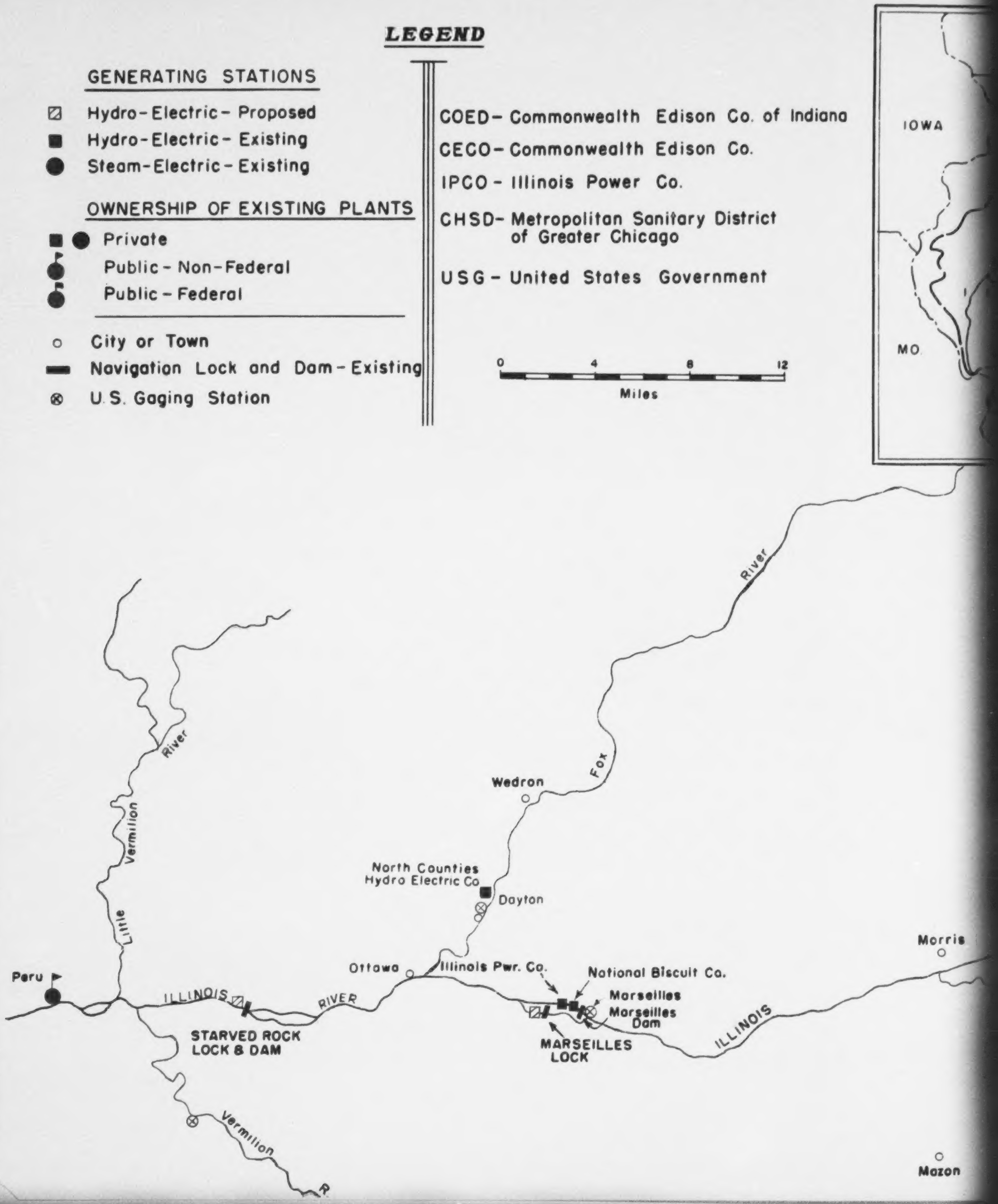
In steam-electric plants, boiler feedwater make-up would be the principal consumptive use, required primarily to replace a small amount of leakage and for boiler cleaning as the boiler and turbine form a closed steam-water system. The cooling water (condenser water) required is obtained by the utilities from the stream upon which the plant is located and is returned to the stream at a slightly higher temperature. The utilities report the minimum amount of cooling water available, but do not report the actual amount used, nor do they report the inlet and discharge temperatures. The Commonwealth Edison Company reports the capability of its steam-electric plants is limited by condenser water temperature during July, August, and September, and the Illinois Power Company reports this limitation from April through October. A comparison of the capabilities in the tabulation shows the reduction of capability to vary from approximately 1.25% to slightly more than 6% of the capability when unlimited by temperature. More data is required than is presently available to determine if the upstream steam-electric plants are affecting those downstream, or if the effect is due primarily to the natural summer increase in temperature. The plants with the lowest percentage decrease in capability probably are affected by the natural temperature change only. The plants with the highest percentage decrease in capability may or may not be affected by the upstream plants.

Figure 5 shows the location and ownership of the utility steam-electric and hydroelectric plants on this portion of the waterway. The locations of four proposed hydroelectric power sites, at existing locks and dams, are also shown.

WASTE DISPOSAL

Municipal Sewage

The municipal sewage inventory activities


LEGEND
GENERATING STATIONS
▨ Hydro-Electric- Proposed
■ Hydro-Electric- Existing
● Steam-Electric- Existing
OWNERSHIP OF EXISTING PLANTS
■ ● Private
Public - Non-Federal
Public - Federal
○ City or Town
Navigation Lock and Dam - Existing
⊗ U.S. Gaging Station
COED- Commonwealth Edison Co. of Indiana
CECO- Commonwealth Edison Co.
IPCO - Illinois Power Co.
CHSD- Metropolitan Sanitary District of Greater Chicago
USG - United States Government
0
4
8
12
Miles
IOWA
MO.
Fox
River
Wedron
North Counties Hydro Electric Co
Dayton
Ottawa
Illinois Pwr. Co.
National Biscuit Co.
Marseilles
Marseilles Dam
MARSEILLES LOCK
Morris
Mazon
ILLINOIS
RIVER
ILLINOIS
STARVED ROCK LOCK & DAM
Peru
Little Vermilion River
Vermilion R.

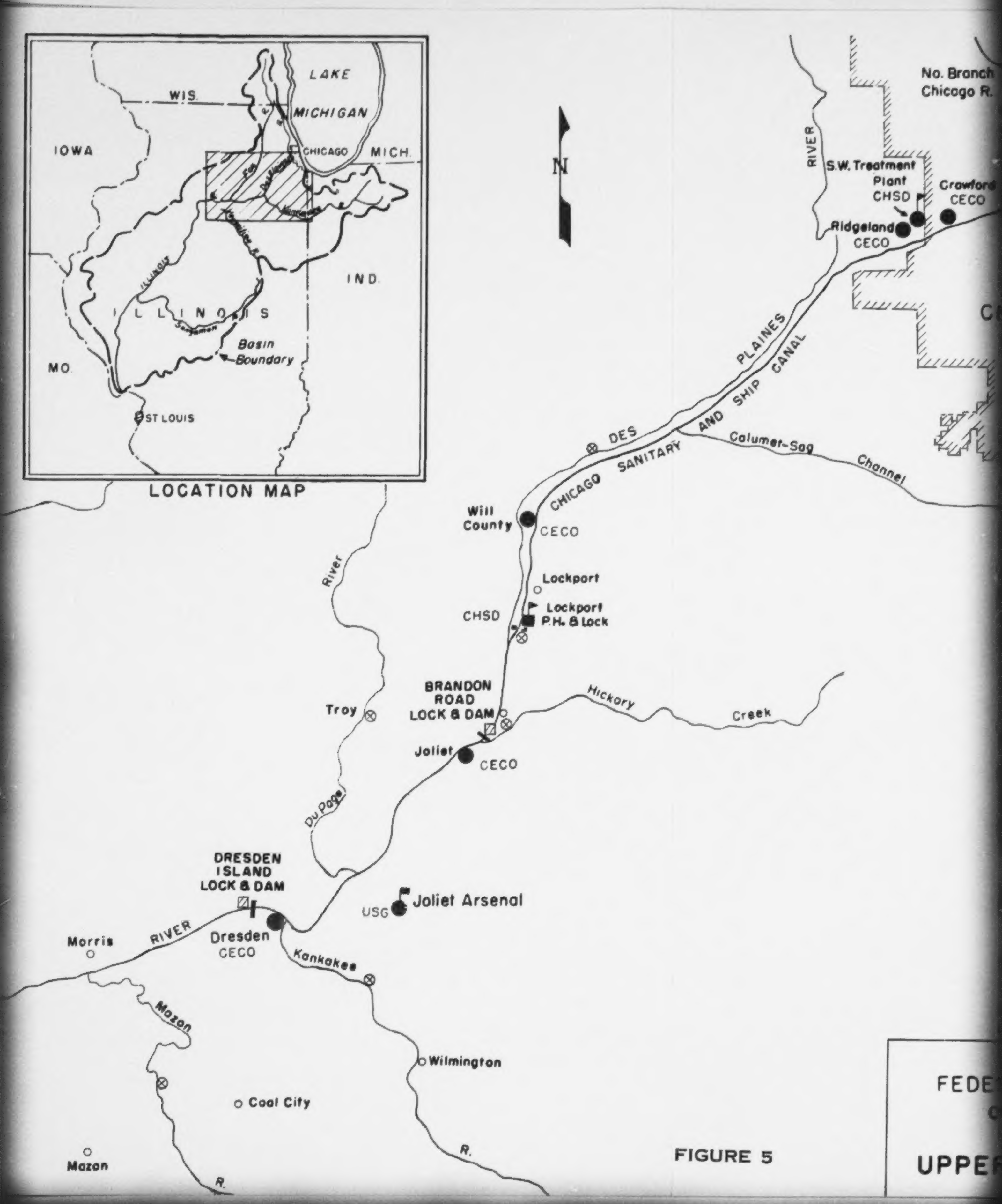
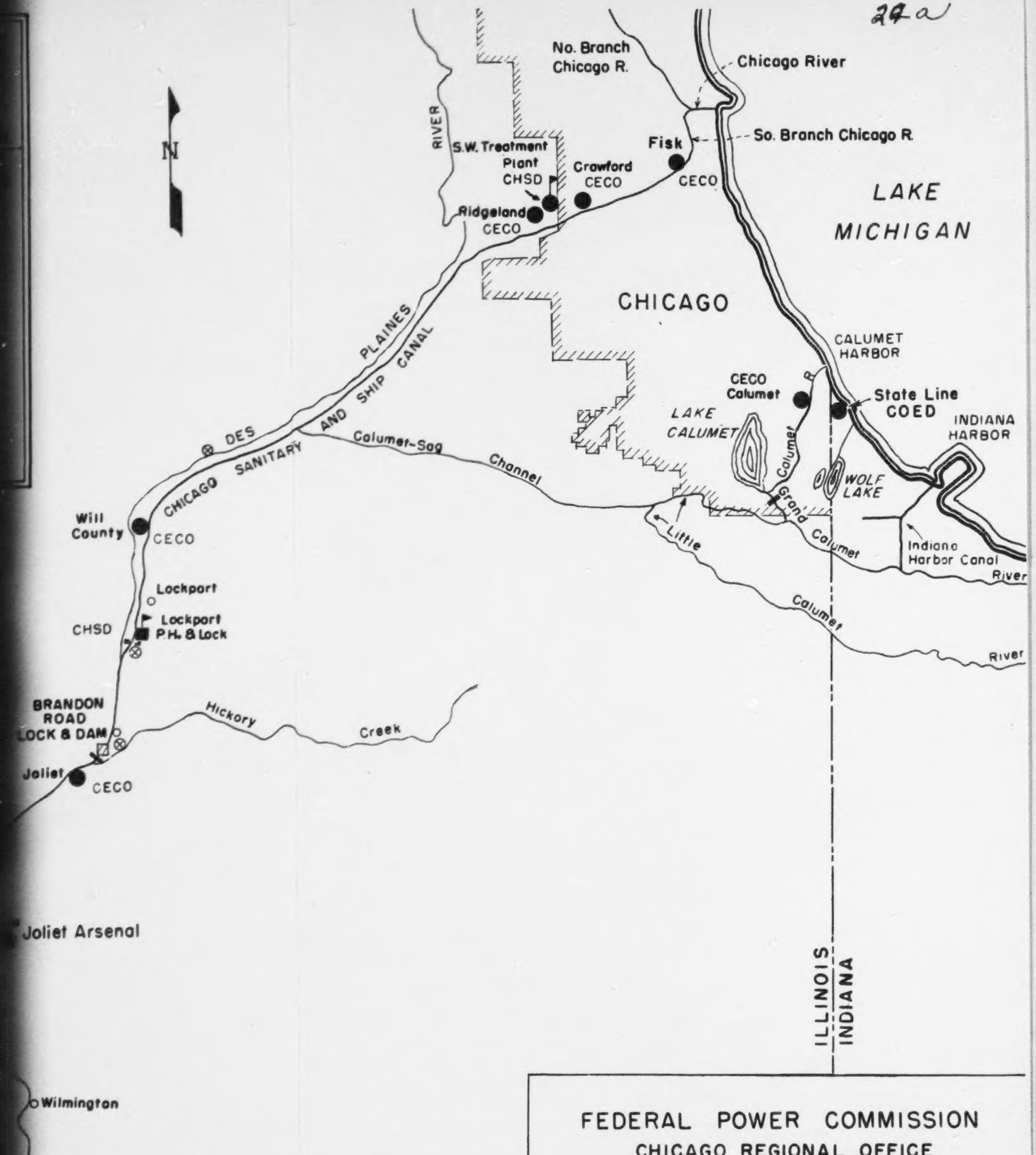

LAKE
MICHIGAN
WIS.
IOWA
CHICAGO
MICH.
IND.
ILLINOIS
Illinois
Fox
Des Plaines
Kankakee
Kankakee R.
Sangamon
Basin Boundary
MO.
ST LOUIS
LOCATION MAP
N
No. Branch
Chicago R.
RIVER
S.W. Treatment Plant
CHSD
Crawford
CECO
Ridgeland
CECO
DES PLAINES
CHICAGO SANITARY AND SHIP CANAL
Calumet-Sag Channel
Will County
CECO
Lockport
Lockport P.H. & Lock
CHSD
River
Troy
BRANDON ROAD LOCK & DAM
Hickory Creek
Joliet
CECO
Du Page
DRESDEN ISLAND LOCK & DAM
Joliet Arsenal
USG
Morris
RIVER
Dresden
CECO
Kankakee
Mazon
Wilmington
Coal City
Mazon
R.
R.
FEDE
C
UPPE

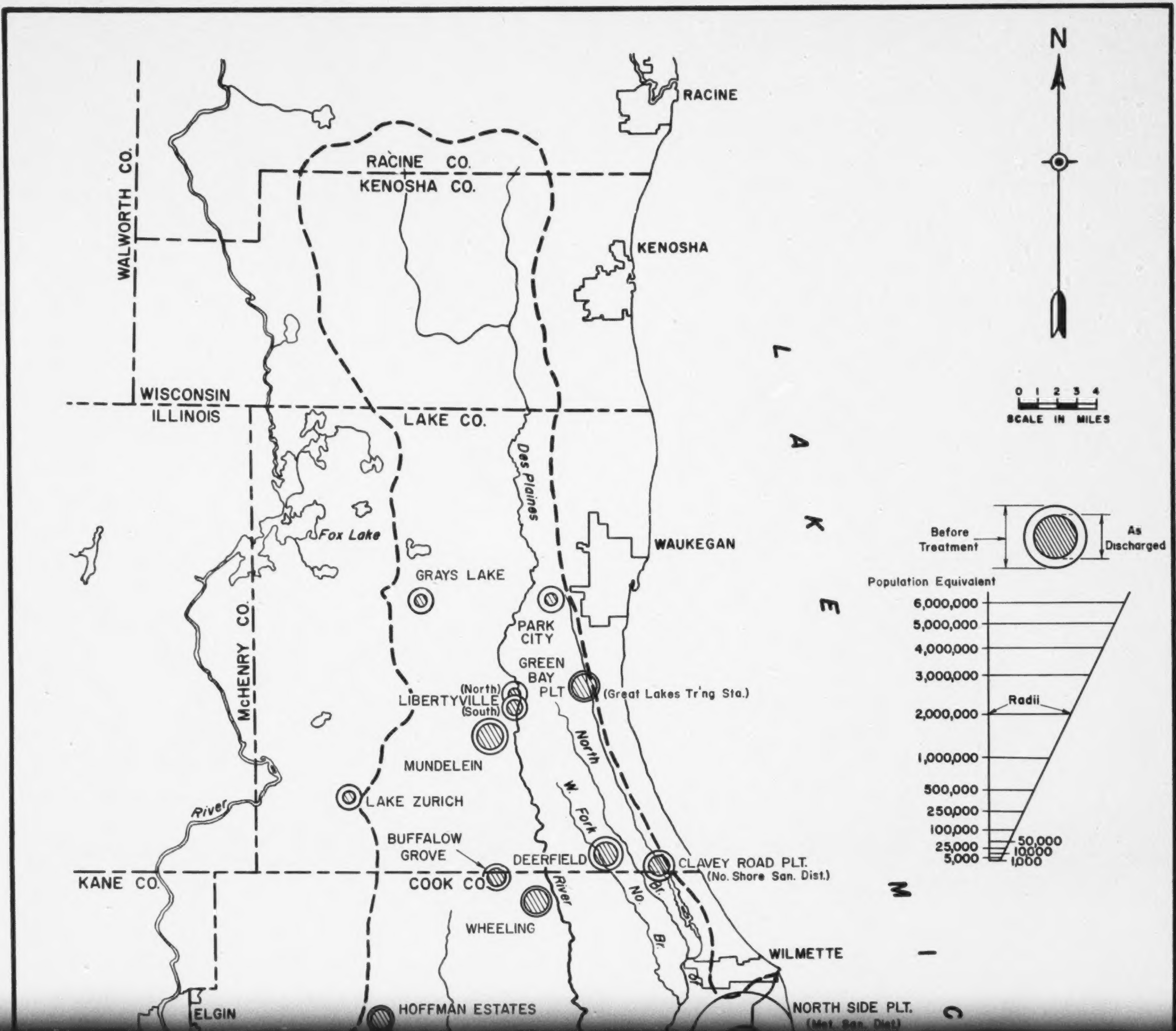
FIGURE 5

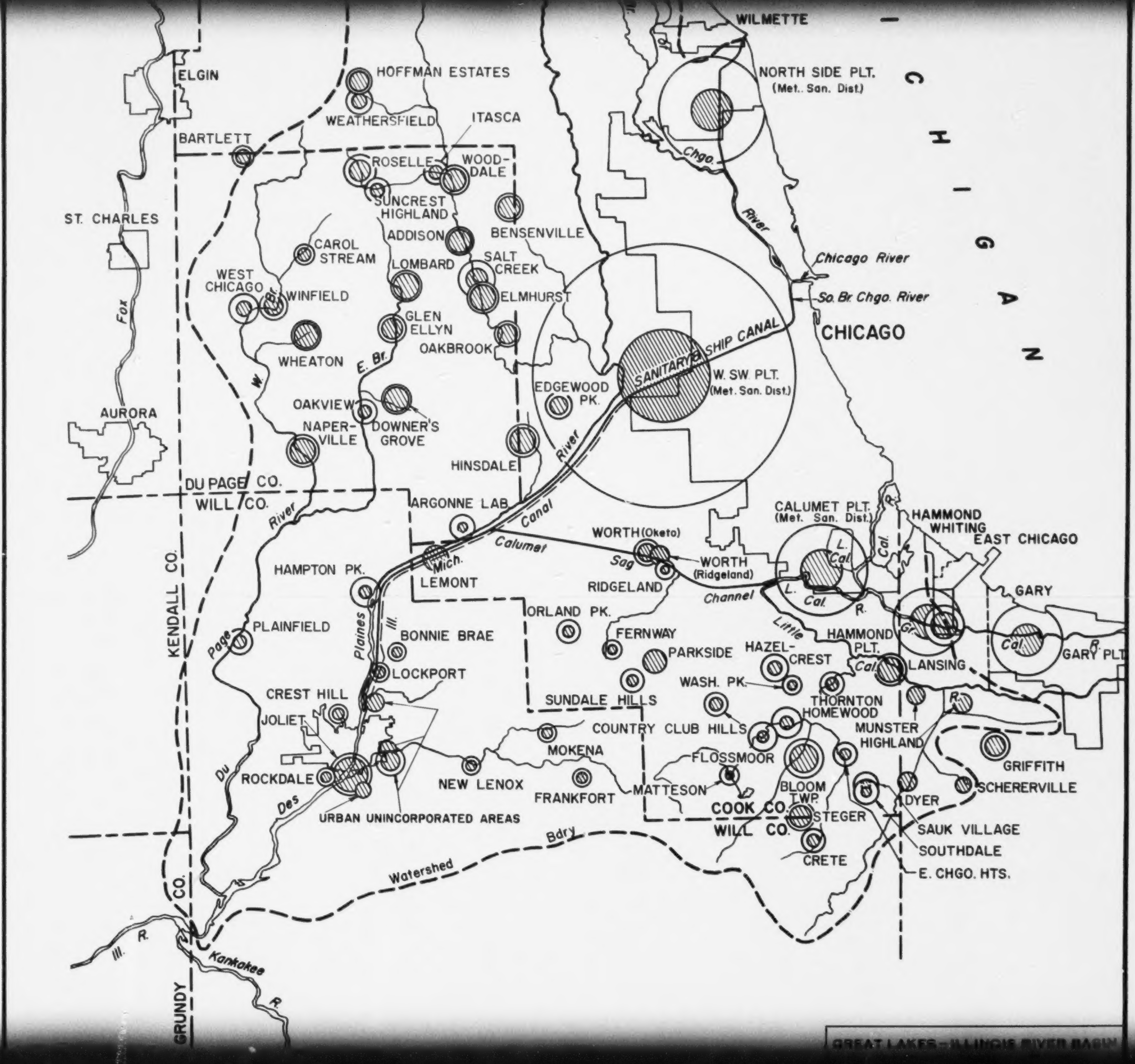

N
RIVER
No. Branch Chicago R.
Chicago River
So. Branch Chicago R.
S.W. Treatment Plant CHSD
Fisk
CECO
Crawford
CECO
Ridgeland
CECO
LAKE MICHIGAN
CHICAGO
DES PLAINES
CHICAGO SANITARY AND SHIP CANAL
Calumet-Sag Channel
CALUMET HARBOR
CECO Calumet
R.
State Line
COED
INDIANA HARBOR
LAKE CALUMET
Calumet
WOLF LAKE
Grand Calumet River
Little Calumet River
Indiana Harbor Canal
Will County
CECO
Lockport
CHSD
Lockport P.H. & Lock
BRANDON ROAD LOCK & DAM
Hickory Creek
Joliet
CECO
Joliet Arsenal
ILLINOIS
INDIANA
Wilmington
R.

FEDERAL POWER COMMISSION
CHICAGO REGIONAL OFFICE

POWER PLANT SITES
UPPER ILLINOIS WATERWAY

FIGURE 5


N
0 1 2 3 4
SCALE IN MILES
Before Treatment
As Discharged
Population Equivalent
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
500,000
250,000
100,000
25,000
5,000
50,000
10,000
1,000
Radii
L A K E M I C
RACINE
KENOSHA
WAUKEGAN
WALWORTH CO.
RACINE CO.
KENOSHA CO.
WISCONSIN
ILLINOIS
LAKE CO.
McHENRY CO.
KANE CO.
COOK CO.
Fox Lake
Des Plaines
River
GRAYS LAKE
PARK CITY
GREEN BAY PLT
(Great Lakes Tr'ng Sta.)
(North) LIBERTYVILLE (South)
MUNDELEIN
LAKE ZURICH
BUFFALOW GROVE
DEERFIELD
CLAVEY ROAD PLT. (No. Shore San. Dist.)
North
W. Fork
No. Br.
Br.
of
WHEELING
WILMETTE
HOFFMAN ESTATES
ELGIN
NORTH SIDE PLT. (Met. San. Dist.)


WILMETTE
NORTH SIDE PLT. (Met. San. Dist.)
L I C H I G A N
Chgo.
River
Chicago River
So. Br. Chgo. River
CHICAGO
SANITARY & SHIP CANAL
W. SW. PLT. (Met. San. Dist.)
ELGIN
HOFFMAN ESTATES
WEATHERSFIELD
ITASCA
BARTLETT
ROSELLE
WOOD-DALE
SUNCREST HIGHLAND
BENSENVILLE
ST. CHARLES
ADDISON
CAROL STREAM
LOMBARD
SALT CREEK
WEST CHICAGO
WINFIELD
ELMHURST
GLEN ELLYN
WHEATON
OAKBROOK
Fox
W. Br.
E. Br.
EDGEWOOD PK.
OAKVIEW
DOWNER'S GROVE
NAPER-VILLE
AURORA
HINSDALE
DU PAGE CO.
WILL CO.
River
ARGONNE LAB.
Canal
Calumet
CALUMET PLT. (Met. San. Dist.)
L. Cal.
Cal.
HAMMOND
WHITING
EAST CHICAGO
WORTH (Oketo)
Sag
WORTH (Ridgeland)
Mich.
LEMONT
RIDGELAND
HAMPTON PK.
Channel
L. Cal.
R.
GARY
ORLAND PK.
Little
HAMMOND PLT.
Gr.
Cal.
GARY PLT.
R.
KENDALL CO.
Page
PLAINFIELD
Plaines
Ill.
BONNIE BRAE
FERNWAY
PARKSIDE
HAZEL-CREST
Cal.
LANSING
LOCKPORT
WASH. PK.
SUNDALE HILLS
THORNTON
CREST HILL
HOMEWOOD
R.
MUNSTER
HIGHLAND
JOLIET
COUNTRY CLUB HILLS
MOKENA
FLOSSMOOR
GRIFFITH
Du
ROCKDALE
NEW LENOX
FRANKFORT
MATTESON
BLOOM TWP.
DYER
SCHERERVILLE
Des
COOK CO.
WILL CO.
STEGER
SAUK VILLAGE
URBAN UNINCORPORATED AREAS
SOUTHDALE
Bdry.
CRETE
Watershed
E. CHGO. HTS.
CO.
Ill. R.
Kankakee
R.
GRUNDY

GREAT LAKES—ILLINOIS RIVER BASIN

26-b

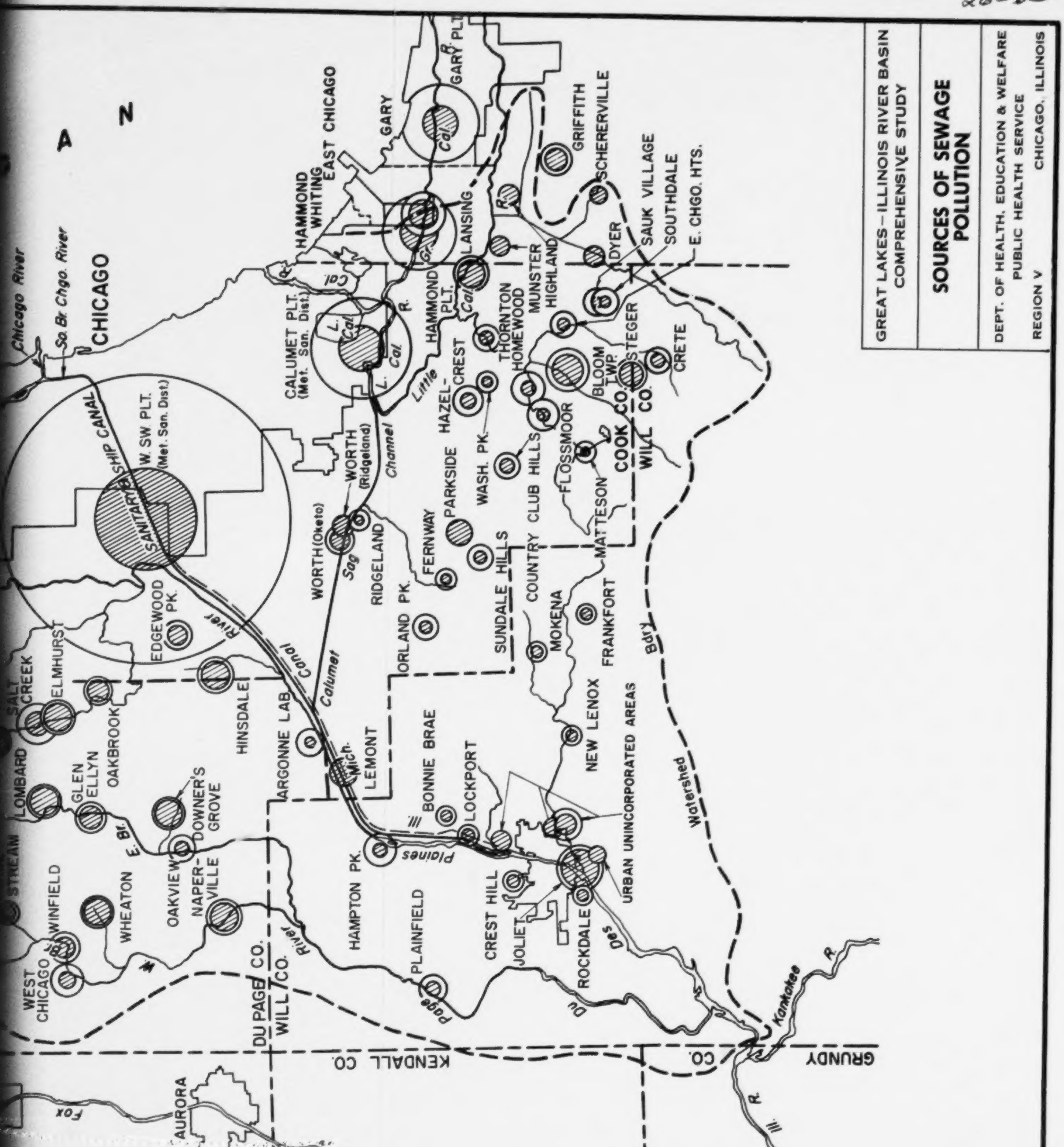

GREAT LAKES–ILLINOIS RIVER BASIN COMPREHENSIVE STUDY
SOURCES OF SEWAGE POLLUTION
DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V
CHICAGO, ILLINOIS
A
N
CHICAGO
Chicago River
So. Br. Chgo. River
SANITARY & SHIP CANAL
W. SW. PLT. (Met. San. Dist.)
CALUMET PLT. (Met. San. Dist.)
HAMMOND
WHITING
EAST CHICAGO
GARY
GARY PLT.
Cal.
Gr.
L. Cal.
Little Cal. R.
HAMMOND PLT.
LANSING
GRIFFITH
SCHERERVILLE
DYER
SAUK VILLAGE
SOUTHDALE
E. CHGO. HTS.
MUNSTER
HIGHLAND
THORNTON
HOMEWOOD
HAZEL-CREST
BLOOM TWP.
STEGER
CRETE
FLOSSMOOR
COUNTRY CLUB HILLS
WASH. PK.
PARKSIDE
FERNWAY
MATTESON
COOK CO.
WILL CO.
WORTH (Ridgeland)
WORTH (Oketo)
Sag Channel
RIDGELAND
ORLAND PK.
SUNDALE HILLS
MOKENA
FRANKFORT
NEW LENOX
URBAN UNINCORPORATED AREAS
Watershed Bdry.
EDGEWOOD PK.
Calumet
Canal
River
ELMHURST
SALT CREEK
HINSDALE
OAKBROOK
ARGONNE LAB
Mich.
LEMONT
BONNIE BRAE
LOCKPORT
LOMBARD
GLEN ELLYN
DOWNER'S GROVE
STREAM
WINFIELD
WHEATON
E. Br.
OAKVIEW
NAPER-VILLE
HAMPTON PK.
Des Plaines
Ill.
CREST HILL
JOLIET
ROCKDALE
PLAINFIELD
WEST CHICAGO
W.
Du Page River
DU PAGE CO.
WILL CO.
KENDALL CO.
GRUNDY CO.
Kankakee R.
Ill. R.
AURORA
Fox

FIGURE 6

GPO 812422—10

for the Illinois River Basin were directed to the upper part of the Basin including the Chicago Metropolitan Area. Communities, institutions, and commercial establishments such as motels, are inventoried under municipal sewage. Unsewered communities are not included in the listings.

A review of available sewerage listings in Federal, State, County, and Metropolitan Sanitary District reports was made together with a search of census, map or atlas sources for additional communities of more than 100 population. This comprised the primary list. The information was subsequently recorded on individual forms and the data updated and completed as far as possible by visits to State, County, District, and local sources of records.

The inventory to date has encompassed Lake, Cook, Will and Du Page Counties, Illinois; Lake and Porter Counties, Indiana; and Kenosha County, Wisconsin. The waterways involved are those in the Upper Illinois River Basin above the Kankakee River junction, and part of the Fox River which enters the waterway below the Kankakee River.

The data have been tabulated by subbasins as follows: North Branch Chicago River, Calumet - Sag Channel and Tributaries, Des Plaines River, Du Page River, and Illinois Waterway and Minor Tributaries (Lake Michigan to the Kankakee River). Systems serving 1,000 or more persons are shown individually, together with identification of the receiving stream, mileage from the point of discharge to the mouth of the stream, degree of treatment, population connected to sewers, population equivalent untreated and discharged. The population equivalent is calculated on a BOD basis from analytical data furnished by the plant or control agency and application of the common factor 1/6 pound per day BOD per population equivalent. In some cases the population connected figure exceeds the computed population equivalent. Some such cases were investigated and found to be predominantly commuter suburbs on the Chicago fringe, which probably accounts for lower BOD loadings from the suburbs. Where industrial wastes of consequence from a BOD standpoint contribute to municipal sewage, the population equivalent usually exceeds the population connected. Systems serving less than 1,000 person are grouped below the individual listings in each table. Where analytical data were not available, engineering estimates were made of the loadings.

Table 12 is a tabulation of the information for the North Branch Chicago River Subbasin. All communities provide sewage treatment. The total sewered population equivalent is 1,127,600. The indicated treatment removes approximately 95% of the organic material with a resulting discharge to streams of 55,500 population equivalent. It is significant to note that the major waste discharge in this subbasin emanates from the North Side Sewage Treatment Works of the Metropolitan Sanitary District.

Data on the Calumet-Sag Channel and its tributaries are shown in Table 13. The municipal waste produced is equivalent to 1,154,500 which is reduced 85% by treatment with the resulting discharge to streams of 174,400 population equivalent. In this subbasin the Calumet Sewage Treatment Works of the Metropolitan Sanitary District is the most significant source of waste discharge. The second largest source is from the Hammond, Indiana, Sewage Plant.

Table 14 is a tabulation of data concerning the Des Plaines River Subbasin. The untreated waste is equivalent to 188,000 population equivalent which is reduced to approximately 81% by treatment to a discharge of 36,300 population equivalent. It may be noted that the population equivalent discharged to the Des Plaines River Subbasin from Cook County is relatively small considering the size of the watershed and its traverse through relatively highly populated areas. The reason for this is that a Metropolitan Sanitary District interceptor sewer parallels this stream and discharges to the Metropolitan Sanitary District West-Southwest Treatment Works. The relevant loading does not, as a consequence, show in the Des Plaines River Subbasin listings but is included in the West-Southwest Works load in the Illinois Waterway Subbasin. The names of the places so served appear in a footnote to the West-Southwest Sewage Treatment Works data shown in Table 16.

Table 15 contains the listings of sources of pollution in the Du Page River Subbasin. Untreated waste amounts to 97,100 population equivalent and treatment, approximately 81%, reduces the discharge to 18,900 population equivalent.

The information regarding the Illinois Waterway and Minor Tributaries Subbasin is depicted in Table 16. The municipal waste produced in this subbasin amounts to 6,415,400

TABLE 11
STEAM-ELECTRIC PLANTS
PART I. DATA ON EXISTING STEAM-ELECTRIC PLANTS

Plant Name (1)	Installed Capacity-kw 12/31/60 (2)	Unlimited by Condenser Water or Ambient Temperature (3)	Limited by Condenser Water or Ambient Temperature (4)	Condenser Water	
				Source (5)	Reported Minimum Available cfs (a) (6)
COMMONWEALTH EDISON COMPANY					
Fisk	709,167	627,000	607,000	South Branch Chicago River	800
Crawford	415,000	365,000	343,000	Chicago Sanitary & Ship Canal	800
Ridgeland	600,000	640,000	616,000	Chicago Sanitary & Ship Canal	1,900
Will County	575,000	585,000	566,000	Chicago Sanitary & Ship Canal	2,100
Joliet	507,000	506,000	486,000	Des Plaines River	2,200
Powerton (near Pekin, Ill.)(d)	320,000	330,000	312,000	Illinois River	2,300
Steam-Electric Plants on Tributaries to Illinois Waterway					
Aurora (Aurora, Ill.)(d)	48,000	52,000	51,000	Fox River	200
Northwest(e)	215,000	222,000	208,000	North Branch Chicago River	450
Calumet	294,500	300,000	283,000	Calumet River	(b)
New Steam-Electric Generating Plant Placed in Service During 1960 - Part of Data Not Yet Available					
Dresden	192,000	180,000	Undetermined at present	Illinois River	3,000
On Lake Michigan					
Waukegan (Waukegan, Ill.)(d)	717,000	723,000	710,000	Lake Michigan	Unlimited
State Line (c)	565,000	562,000	555,000	Lake Michigan	Unlimited
METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO					
Southwest Treatment Plant	18,000 kw - no condenser water used. Steam used pricipally for sewage treatment purposes.				
PERU, ILLINOIS MUNICIPAL					
Peru, Illinois	15,250 capability not reported.			Illinois River	
ILLINOIS POWER COMPANY					
Hennepin, Illinois(d)	306,250	316,000	307,000	Illinois River	More than required
Havana, Illinois(d)	230,000	264,000	260,000	Illinois River	More than required
CENTRAL ILLINOIS LIGHT COMPANY					
R.S. Wallace (E. Peoria)(d)	325,445	320,000	Not Limited	Illinois River	Not Limited
E. D. Edwards (Nr. Bartonville)(d)	136,000	133,000	Not Limited	Illinois River	Not Limited
Liberty St. (Peoria)(d)	22,000	25,000	Not Limited	Illinois River	Not Limited
CENTRAL ILLINOIS PUBLIC SERVICE COMPANY					
Meredosia, Ill. (d)	300,000	353,000	346,000	Illinois River	Not Limited

(a) Amount required is not reported by utility.
(b) Dependent upon the level of Lake Michigan and the diversion at the locks near Lake Calumet.
(c) Owned and operated by Commonwealth Edison Company of Indiana, Inc. a subsidiary of Commonwealth Edison Company.
(d) Not shown on attached map. Located at town indicated.
(e) In City of Chicago, on North Branch Chicago River, a little north of area shown on map.

TABLE 11 (Continued)
STEAM-ELECTRIC PLANTS
PART II PLANT ADDITIONS SCHEDULED

Plant Name	New Capacity kw	Scheduled Completion Date	Remarks
COMMONWEALTH EDISON COMPANY AND SUBSIDIARY			
Crawford	325,000	April 1961	Under construction (not reported in service)
Waukegan	325,000	June 1962	Under construction
Will County	532,000	April 1963	Under construction
Joliet	560,000	Feb. 1965	Authorized
Location not determined	560,000	1965 or 1966	Authorized
State Line	325,000	May 1962	Under construction[a]
Retirements Scheduled			
Crawford	91,500	Sept. 1961	To be removed to make room for installation of larger, more efficient units.
Crawford	104,000	Feb. 1965	

(a) Owned and operated by Commonwealth Edison Company of Indiana, Inc., a subsidiary of Commonwealth Edison Company.

population equivalent. An average treatment of 89% reduces the waste discharged to 715,400 population equivalent. It may be noted that the largest source of waste is from the West-Southwest Treatment Works. The second largest source is from Joliet, Illinois.

Table 17 summarizing the five subbasins indicates that 308 separate communities, institutions and commercial establishments are served by 202 sewage works in the Upper Illinois River Basin. The estimated total population equivalent before treatment is 8,983,000 of which 1,000,000 population equivalent is discharged to the streams of the Upper Basin. Of the 202 municipal systems, 91% provide secondary treatment, 2% primary treatment and the remaining 7% little or no treatment. The composite reduction in population equivalent computed from the "before treatment" and "as discharged" figures is 89%. The influence of the three large Metropolitan Sanitary District Treatment Works predominates in the Upper Basin total figures. as well as in those of the separate subbasins. In the Upper Basin, these three plants account for some 85% of the total population connected to sewers, 89% of the total population equivalent before treatment and 77% of the population equivalent in sewage treatment plant effluents discharged to streams in the Upper Basin. Individual loadings and their locations are shown in Figure 6.

In addition to sewered or partly sewered sources of municipal sewage pollution covered in this inventory there are unsewered areas in the Upper Basin in which difficulties with individual septic tank-soil absorption systems, because of unfavorable internal soil drainage characteristics or other factors, has resulted in escape of effluent or raw sewage to ditches, etc. These result in local nuisance problems, although there may be some cases in which the aggregate contribution to the local watercourse may be considerable. In general these are matters of local sanitation.

TABLE 12
SOURCES OF SEWAGE POLLUTION
NORTH BRANCH CHICAGO RIVER SUBBASIN

Community, Sewer or Sanitary District, Institution	Receiving Stream (direct)	Miles Above Mouth of Branch	Treatment	Estimated Population Connected to Sewers[a]	Estimated Sewered Population Equivalent (BOD Basis)	
					Untreated[a]	Discharged[a]
ILLINOIS - LAKE COUNTY						
Waukegan-Park City Trailer Park	Skokie Creek	44.7	Primary[b]	1,200	1,200	800
Great Lakes Naval Tr. Sta. Green Bay Plant	Skokie Creek	42.0	Secondary	7,500	8,400	800
North Shore San. District Clavey Road Plant[c]	Skokie Creek	30.3	Secondary	10,000	11,000	1,500
Deerfield[d]	Union Dr. Dth.	30.9	Secondary	12,000	19,300	3,700
Smaller Sources - Three			All Secondary	600	600	100
SUBTOTALS				31,300	40,500	6,900
ILLINOIS - COOK COUNTY						
North Side Plant(MSD)[e]	N. Shore Chnl.	10.1	Secondary	1,231,000[f]	1,086,000[f]	48,400[f]
Smaller Sources - Four			All Secondary	1,100	1,100	200
SUBTOTALS				1,232,100	1,087,100	48,600
TOTALS FOR SUBBASIN				1,263,400	1,127,600	55,500

(a) Some entries tentative and subject to adjustment.
(b) Single and communal septic tanks partly discharging to Creek.
(c) Serves parts of Highland Park, Highwood and scattered unincorporated areas and commercial establishments.
(d) Includes contribution from Bannockburn.
(e) Serves Evanston, Glencoe, Glen Oak Acres S.D., Glenview, Golf, Kenilworth, Lincolnwood, Morton Grove, Niles, Northbrook, Northfield, Northfield Woods, Skokie, Wilmette, Winnetka, Canfield community.
(f) Preliminary figures.

TABLE 13
SOURCES OF SEWAGE POLLUTION
CALUMET - SAG CHANNEL AND TRIBUTARIES SUBBASIN(b)

Community, Sewer or Sanitary District, Institution (1)	Receiving Stream (Direct) (2)	Miles Above Mouth of Branch (3)	Treatment (4)	Estimated Population Connected to Sewers(a) (5)	Estimated Sewered Population Equivalent (BOD Basis)	
					Untreated(a) (6)	Discharged(a) (7)
ILLINOIS - WILL COUNTY						
Crete	Dth. to Deer Cr.	42.6	Secondary	3,500	3,500	1,000
Steger(c)	Third Creek	39.9	Secondary	6,400	6,400	1,300
Smaller Sources - One			Minor	300	300	300
SUBTOTALS				10,200	10,200	2,600
ILLINOIS - COOK COUNTY						
Sauk Village & Indian Hill	Lansing Dr. Dth.(m)	43.4	Secondary	2,600	2,100	300
Southdale Subdivision	Lansing Dr. Dth.	42.4	Secondary	1,200	800	100
Matteson	Butterfield Cr.	41.1	Secondary	3,000	3,000	200
East Chicago Heights	Deer Creek	37.2	Secondary	3,300	3,300	500
Bloom Township San. Dist.(d)	Thorn Creek	36.5	Secondary	68,000	77,000	16,900
Flossmoor	Butterfield Cr.	35.5	Secondary	4,600	4,600	700
Homewood	Butterfield Cr.	34.6	Secondary	14,000	15,000	1,400
Washington Pk. Race Track	Dth. to Thorn Cr.	33.8	Secondary	20,000	1,000	100
Thornton	Thorn Cr.	29.4	Secondary	2,900	2,900	400
Country Club Hills Subdiv.	Cal. Un. Dr. Dth.	29.0	Secondary	3,400	3,400	500
Lansing	Little Cal. R.	28.3	Secondary	18,000	18,000	3,600
Sundale Hills Subdiv.	Midlothian Cr.	28.0	Secondary	1,400	1,900	200
Park Side Subdiv.(e)	Midlothian Cr.	26.3	None(e)	None	2,800	2,800
Hazel Crest	Cal. Un. Dr. Dth.	26.2	Secondary	6,200	6,200	600
Fernway Subdiv.	Tinley Cr.	18.8	Secondary	1,300	1,400	100
Calumet Plant (MSD)(f)	Cal-Sag Channel	17.9	Secondary	596,500	624,000	74,000
Ridgeland Water Svcs Co.(g)	Cal-Sag Channel	11.4	Secondary	1,200	1,200	100
Orland Park Plant (MSD)	McG. Sl. to Mill Cr.	10.2	Secondary	1,700	1,100	100
Worth-Ridgeland Plt. (MSD)	Cal-Sag Channel	9.0	Primary(h)	3,800	3,800	3,800
Worth-Oketo Ave. Plt. (MSD)	Cal-Sag Channel	8.0	Primary(i)	4,300	4,300	2,800
Smaller Sources - 26			All Secondary	5,700	6,100	800
SUBTOTALS				763,100	783,900	110,000
INDIANA - LAKE COUNTY						
Schererville	Cady Marsh-Hart	37.9	Minor(k)	1,300	1,300	1,000
Dyer	Hart Ditch	37.0	Minor(k)	3,600	3,600	3,000
Griffith (part)	Cady Marsh-Hart	36.5	Minor(l)	7,100	7,100	5,700
Highland (part)	Little Cal. R.	33.6	None	6,100	6,100	6,100
Munster (part)	Little Cal. R	31.3	None	6,800	6,800	6,800
East Chicago	Grand Cal. R.	27.9	Secondary	57,700	53,300	6,500
Hammond(j)	Grand Cal. R.	26.8	Secondary	132,000	282,000	32,600
Smaller Sources - One			Secondary	200	200	100
SUBTOTALS				214,800	360,400	61,800
TOTALS FOR SUBBASIN				988,100	1,154.500	174,400

(a) Some entries tentative and subject to adjustment.
(b) Includes Indiana sources discharging west of weak divides on the Grand Calumet River just west of Indiana Harbor Canal, Mile 26.1 and on Little Calumet River at Mile 39.9. Divides may move easterly or westerly somewhat depending on rains, floods and lake levels. Not included is Gary Main Plant discharging about 18,200 population equivalent at Mile 36.1 to Grand Calumet River, flow of which may divide at Indiana Harbor Canal at times.
(c) The population of Steger is divided 4,300 Will County and 2,100 Cook County.
(d) Serves Park Forest, Chicago Heights, South Chicago Heights.
(e) Now being sewered for a proposed treatment plant, now partly sewered, septic tanks, etc. with large percentage discharging to Midlothian Creek.
(f) Serves Alsip, Blue Crest, Blue Island, Burnham, Calumet City, Calumet Park, Canterbury Gardens, Chicago Ridge, Dixmoor, Dolton, Evergreen Park, Garden Homes, Harvey, Markham, Merrionette Park, Midlothian, Oak Lawn, Phoenix, Posen, Riverdale, Robbins, South Holland, Keystone Additions, Manor Heights Subdivision, Martin Roberts Subdivision (Oaklawn), and South Stickney.
(g) Sewers and treatment plant serve Crestwood.
(h) Plant broken down, septic, by-passed so frequently considered ineffective. Is a temporary plant.
(i) Temporary facility.
(j) Includes contributions from Whiting, Munster (part) and Highland (part).
(k) Variously raw or/and individual septic tank effluents discharged to storm sewers, tile outfalls to ditches.
(l) Community sewers receive individual septic tank discharges. Other part to Lake Michigan tributaries.
(m) "Dr." Dth".: Drainage Ditch.

TABLE 14
SOURCES OF SEWAGE POLLUTION
DES PLAINES RIVER SUBBASIN

Community, Sewer or Sanitary District, Institution (1)	Receiving Stream (direct) (2)	Miles Above Mouth of Branch (3)	Treatment (4)	Estimated Population Connected to Sewers(a) (5)	Estimated Sewered Population Equivalent (BOD Basis)	
					Untreated(a) (6)	Discharged(a) (7)
WISCONSIN - KENOSHA COUNTY						
No known sources of significance in this Subbasin						
ILLINOIS - LAKE COUNTY						
Gray's Lake	Mill Creek	95.4	Secondary	3,800	2,700	200
Mundelein(b)	Hawthorne Creek	69.6	Secondary	10,500	14,900	2,500
Libertyville, No. Plant	Des Plaines R.	69.2	Secondary	4,100	2,700	200
Libertyville, So. Plant	Des Plaines R.	67.5	Secondary	4,400	3,900	600
Smaller Sources - 12			Various(c)	1,800	1,800	400
SUBTOTALS				24,600	26,000	3,900
ILLINOIS - COOK COUNTY						
Hoffman Estates	Dth. to Salt Cr.	65.0	Secondary	8,800	10,200	1,500
Buffalo Gr.Plant(MSD)(d)	Buffalo Cr.	59.3	Secondary	3,000	3,200	500
Wheeling Plant (MSD)	Wheeling Dr. Dth.	56.3	Secondary	8,400	8,600	1,100
Edgewood Park Subd.	Dth. to Des P.R.	26.3	Secondary	1,200	1,200	100
Smaller Sources - 28			All Secondary	6,200	5,700	1,000
SUBTOTALS				27,600	28,900	4,200
ILLINOIS - DU PAGE COUNTY						
Bensenville	Salt Creek	63.1	Secondary	8,600	8,700	2,500
Roselle	Meecham Creek	59.5	Secondary	3,600	4,800	1,400
Suncrest Highland	Meecham Creek	58.8	Secondary	1,300	1,300	400
Itasca	Itasca Creek	56.2	Secondary	3,500	3,500	500
Salt Creek S. D. (e)	Salt Creek	53.5	Secondary	19,000	37,500	3,300
Wood Dale	Salt Creek	52.9	Secondary	2,500	2,500	400
Hinsdale S. D. (f)	Flag Creek	52.0	Secondary	24,000	29,800	4,000
Addison	Salt Creek	50.0	Secondary	6,700	5,300	1,200
Elmhurst	Salt Creek	45.2	Secondary	36,900	28,200	13,000
Oak Brook	Salt Creek	42.4	Secondary	1,400	1,400	200
Argonne Nat'l. Lab.	Sawmill Creek	13.7	Tertiary	1,400	1,400	100
Smaller Sources - 20			All Secondary	4,200	3,200	500
SUBTOTALS				113,100	127,600	27,500
ILLINOIS - WILL COUNTY						
Hampton Park Subd.	Des Plaines R.	6.9	Secondary	5,000	5,000	500
Smaller Sources - 2			Various(g)	400	500	200
SUBTOTALS				5,400	5,500	700
TOTALS FOR SUBBASIN				170,700	188,000	36,300

(a) Some entries tentative and subject to adjustment.
(b) Includes contribution from Bannockburn.
(c) Ten receive secondary treatment, one primary and the remaining one no treatment.
(d) Serves Buffalo Grove and various subdivisions and unincorporated areas.
(e) Serves Villa Park.
(f) Serves Hinsdale, Clarendon Hills, part of Westmont and several unincorporated areas.
(g) One receives secondary treatment, the other, none (to be connected to Joliet in 1961).

TABLE 15
SOURCES OF SEWAGE POLLUTION
DU PAGE RIVER SUBBASIN

Community, Sewer or Sanitary District, Institution (1)	Receiving Stream (direct) (2)	Miles Above Mouth of Branch (3)	Treatment (4)	Estimated Population Connected to Sewers[a] (5)	Estimated Sewered Population Equivalent (BOD Basis) Untreated[a] (6)	Estimated Sewered Population Equivalent (BOD Basis) Discharged[a] (7)
ILLINOIS - COOK COUNTY						
Weathersfield Subdivision[b]	Dth. to W. Br. D. P. R.	61.4	Secondary	1,100	1, 100	200
Bartlett Plant (MSD)	Dth. to W. Br. D. P. R.	55.6	Secondary	1, 700	2, 800	500
Smaller Source - One			All Secondary	500	500	100
SUBTOTALS				3, 300	4, 400	800
ILLINOIS - DU PAGE COUNTY						
Lombard	E. BR. DuP. R.	47.3	Secondary	21, 600	9, 100	2, 600
West Chicago	W. Br. DuP. R.	45.3	Secondary	6, 800	9. 300	500
Winfield[e]	W. Br. DuP. R.	45.3	Secondary[e]	1, 600[e]	1, 600[e]	300[e]
Downers Grove	St. Josephs Cr.	44.9	Secondary	20, 000	17, 000	3, 300
Glen Ellyn	E. Br. DuP. R.	44.5	Secondary	15, 900	6, 300	1, 900
Wheaton SD.	W. Br. DuP. R.	42.7	Secondary	23, 700	21, 200	5, 300
Oak View Subd.	E. Br. DuP. R.	39.0	Secondary	1, 300	1, 400	500
Naperville	W. Br. DuP. R.	32.8	Secondary	13, 500	18, 900	1, 800
Smaller Sources-Thirteen			All Secondary	3, 200	3, 200	600
SUBTOTALS				107, 600	88, 000	16, 800
ILLINOIS - WILL COUNTY						
Plainfield	Du Page R.	18.8	Secondary	1, 600	1, 600	500
Crest Hill City[c]	Rock Run Cr.	16.8	Secondary	1, 200	1, 200	200
Rockdale	I & M Canal	10.3	Secondary	1, 300	1, 100	200
Smaller Sources - Two			Various[d]	800	800	400
SUBTOTALS				4, 900	4, 700	1, 300
TOTALS FOR SUBBASIN				115, 800	97, 100	18, 900

(a) Some entries tentative and subject to adjustment.

(b) Serves Shaumberg and Shaumberg Center, except Hoffman Estates.

(c) Incorporated 1960 absorbing Lidice Subdivision. Other absorbed subdivisions are on septic tank tile field systems or connected to Joliet sewage treatment works.

(d) One receives secondary treatment; the other is not treated.

(e) Not yet in operation-scheduled for completion in July, 1961. Currently part of sewage temporarily received by Wheaton S. D. for treatment; the remainder is served by private septic tank systems.

TABLE 16
SOURCES OF SEWAGE POLLUTION
ILLINOIS WATERWAY & MINOR TRIBUTARIES SUBBASIN
(LAKE MICHIGAN TO KANKAKEE RIVER)

Community, Sewer or Sanitary District, Institution	Receiving Stream (direct)	Miles Above Mouth of Branch	Treatment	Estimated Population Connected to Sewers[a]	Estimated Sewered Population Equivalent (BOD Basis) Untreated[a]	Estimated Sewered Population Equivalent (BOD Basis) Discharged[a]
ILLINOIS - COOK COUNTY						
WSW Plt(MSD)[b]	Ill. Waterway	315.8	Secondary	2,907,500	6,320,000	651,000
Lemont	I & M Canal	300.5	None(c)	3,400	3,400	3,400
Smaller Sources - Five			All Secondary	1,500	1,100	200
SUBTOTALS				2,912,400	6,324,500	654,600
ILLINOIS - WILL COUNTY						
Frankfort	Br. Hickory Cr.	301.9	Secondary	1,100	1,100	200
Mokena	Br. Marley Cr.	300.4	Secondary	1,300	1,300	300
Bonnie Brae Subd.	Big Run Cr.	294.6	Secondary	1,400	1,400	300
New Lenox	Hickory Cr.	294.5	Secondary	1,700	1,700	300
Lockport	Deep Run Cr.	292.2	Primary	7,500	5,000	2,600
Joliet	Spg. & Hickory Creek	(286.5-290.0)	Primary & None	71,600	71,600	50,100
Joliet Fringe-Urban Unicorp.	I & M,Hickory	(286.2-290.0)	Minor	6,000	6,000	6,100
Smaller Sources - Eight			Various[d]	3,400	2,800	1,000
SUBTOTALS				94,000	90,900	60,900
TOTALS FOR SUBBASIN				3,006,400	6,415,400	715,500

(a) Some entries tentative and subject to adjustment.

(b) Serves Arlington Heights, Bellwood, Berkeley, Berwyn, Brickman Manor, Broadview, Brookfield, Central Stickney S.D., Cicero, Des Plaines, Elk Grove, Elmwood Park, Forest Park, Forest View, Franklin Park, Grandview (Oak Lawn), Harwood Heights, Highland (La Grange), Hillside, Hometown, La Grange, La Grange Park, Lyons, Manor Heights S.D., Maywood, McCook, Melrose Park, Mt. Prospect, Norridge, Northlake, North Riverside, Oak Park, Orchard Place S.D., Palatine, Palatine Heights, Park Ridge, Plum Grove Estates, Prospect Meadows S.D., Riverside, River Grove, River Forest, Rolling Meadows, Rosemont, Schiller Park, South Stickney S.D., Stickney, Stone Park, Summit, Westchester, Western Springs, Bedford Park, Countryside S.D. (Edgewood & Edgewood Park). Algonquin Road, Blackhawk Subdivision (Palatine), Bluett, Cumberland Heights, Greenwood Gardens (Des Plaines Subdivision), Gunnison Improvement Club and Hodgkins.

(c) To be served by a secondary treatment plant in three months.

(d) Seven receive secondary treatment, one minor.

TABLE 17 - SUMMARY
SOURCES OF SEWAGE POLLUTION
UPPER ILLINOIS RIVER BASIN

River Basin	Number		Treatment			Estimated Population Connected to Sewers(a)	Estimated Sewered Population Equivalent (BOD Basis)	
	Places Served	Sewage Works	Minor or None	Primary	Secondary		Untreated(a)	Discharged(a)
North Branch Chicago River	29	12	1	-	11	1,263,400	1,127,600	55,500
Cal-Sag Channel and Tributaries	86	57	7	2	48	988,100	1,154,500	174,400
Des Plaines River	84	82	2	1	79	170,700	188,000	36,300
Du Page River	30	29	1	-	28	115,800	97,100	18,900
Illinois Waterway and Minor Tributaries (Lake Michigan to Kankakee River)	79	22	3	2	17	3,006,400	6,415,400	715,500
TOTALS - UPPER ILLINOIS RIVER	308	202	14	5	183	5,544,400	8,982,600	1,000,600

(a) Some entries tentative and subject to adjustment.

INDUSTRIAL WASTES

Records of the Metropolitan Sanitary District of Greater Chicago indicate that an industrial waste load of about 70,000 population equivalent (PE) is discharged directly to the waterways. Industrial waste sources outside of the Metropolitan Sanitary District total about 115,000 PE. This inventory is incomplete and does not represent the total load.

Metropolitan Sanitary District

Present Conditions

The records of the Metropolitan Sanitary District of Greater Chicago were studied to determine the amount of industrial waste discharged directly to the waterways within the Sanitary District. The criterion of significance used in preparing this inventory is population equivalent based on the five-day biochemical oxygen demand.

The present known sources of industrial waste BOD to the waterways total 68,720 PE. These are distributed by the subbasin as follows:

	No. of Plants	
Illinois Waterway	15	33,820 PE
Cal - Sag Channel	6	26,590 PE
North Branch Chicago River	9	7,390 PE
Des Plaines River	4	920 PE
Total	34	68,720 PE

Table 18 contains detailed information on the industrial waste inventory. Figure 7 shows the locations of the industrial waste sources.

The three plants with the highest indicated BOD loads, totaling 45,590 PE, have been visited jointly by representatives of the Public Health Service and the Metropolitan Sanitary District. Conditions and probable waste loads were found to be essentially as reported by the Metropolitan Sanitary District.

It might be questioned whether this inventory realistically represents the BOD load entering the waterways from industrial sources within the Metropolitan Sanitary District. It is known that there are several other unevaluated sources of waste that are not included in this inventory. Their total is reported to be small.

Historical Comparison

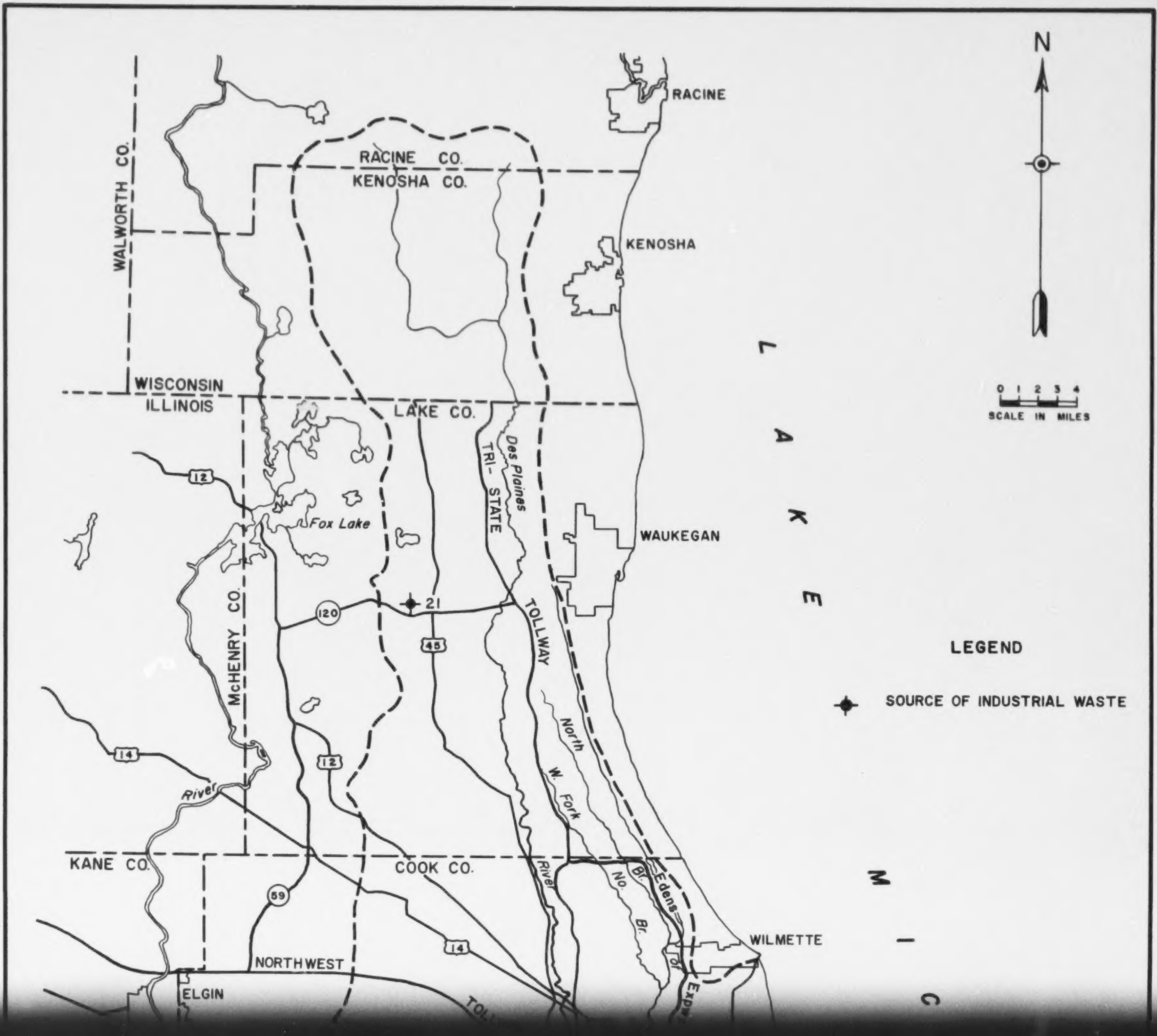
The Illinois Waterway was last studied comprehensively by the United States Public Health Service in 1921-22.(3). At that time nearly all domestic and industrial waste entered the waterways without treatment. The Calumet-Sag Channel had not been constructed; therefore, 71% of Cook County was drained by the Illinois Waterway and tributaries, contrasted with nearly 100% today. The Public Health Service estimated the industrial waste load in the area drained by the Illinois Waterway and the North Branch of the Chicago River, but not the Des Plaines River, to have been 1,885,600 PE. The present inventory shows an industrial waste load directly to the waterways of 68,720 PE in the Metropolitan Sanitary District. The waste load to the Illinois Waterway and the North Branch of the Chicago River is 41,210 PE. Therefore, in a comparable area, the present industrial waste load to the waterways is 2.2% of the load estimated by the Public Health Service in 1921-22.

The diversion of industrial waste from the waterways has been accomplished gradually by the Metropolitan Sanitary District by inducing industries to discharge their wastes to the sewer system for treatment at the Sanitary District Sewage Treatment Works. In most cases the entire flow of waste has been accepted into the sewer system. However, in some cases the organic wastes have been segregated for discharge to the sewer system, and larger flows relatively free of organic material have been allowed to flow to the waterways.

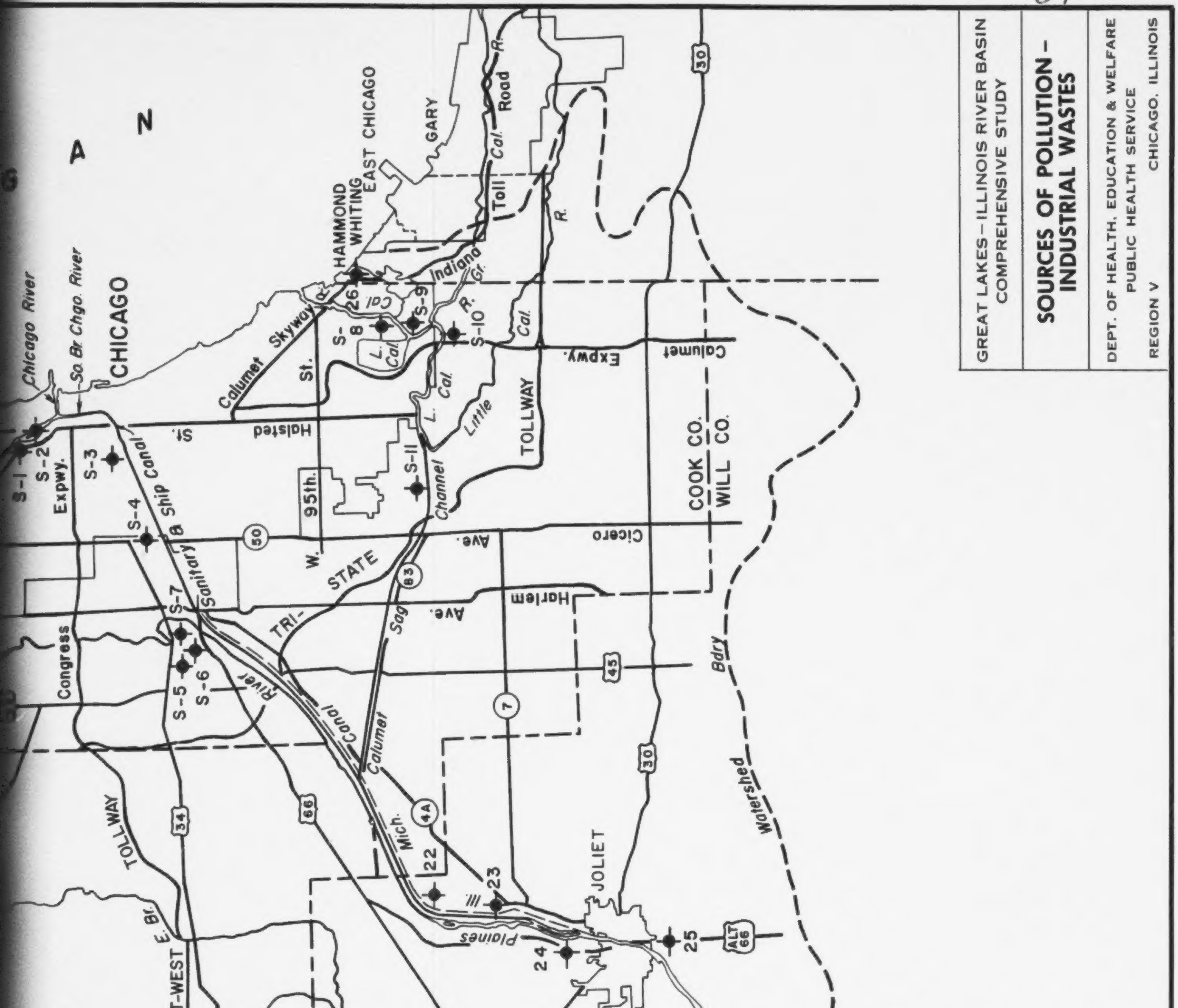
Results accomplished at a by-product coke plant on the Calumet River will illustrate the gradual progress by the Sanitary District in inducing industries to divert waste from the stream. Six different sampling runs were made between 1936 and 1954. The 1936 and 1954 results are as follows:

Year	MGD to River	BOD lbs/24 hrs.	Phenol lbs/24 hrs.	Coal tons/24 hrs.
1936	6.4	4,927	2,826	1,916
1954	2.7	697	52	1,156

The Public Health Service reported that in 1921-1922 the principal sources of industrial waste in the Illinois Waterway Basin were the meat packing industry, tanneries, corn products factories, paper, pulp, and strawboard mills, distilleries, alcohol manufacturers,


N
SCALE IN MILES
0 1 2 3 4
LEGEND
SOURCE OF INDUSTRIAL WASTE
LAKE MIC
RACINE
KENOSHA
WAUKEGAN
WILMETTE
ELGIN
RACINE CO.
KENOSHA CO.
WALWORTH CO.
WISCONSIN
ILLINOIS
LAKE CO.
McHENRY CO.
KANE CO.
COOK CO.
Fox Lake
Des Plaines
River
TRI-STATE
TOLLWAY
North
W. Fork
No. Br.
Br.
Edens
Expw
NORTHWEST
TOLL
River
21
120
45
12
12
14
14
59

37-a


G
A
N
CHICAGO
Chicago River
So. Br. Chgo. River
HAMMOND
WHITING
EAST CHICAGO
GARY
Calumet Skyway
Indiana Hbr. Cal.
Toll Road
Cal. R.
L. Cal.
Little Cal. R.
TOLLWAY
Calumet Expwy.
Halsted St.
St.
W. 95th.
Cicero Ave.
Harlem Ave.
TRI-STATE
Cal Sag Channel
Sanitary & Ship Canal
Des Plaines River
Calumet
Mich. Canal
Ill.
Congress Expwy.
COOK CO.
WILL CO.
DU PAGE CO.
WILL CO.
KENDALL CO.
GRUNDY CO.
Watershed Bdry.
EAST-WEST TOLLWAY
E. Br.
Br.
Du Page River
Des Plaines
JOLIET
AURORA
Fox
Kankakee R.
Ill. R.
30
50
83
45
7
4A
66
34
ALT 66
S-1
S-2
S-3
S-4
S-5
S-6
S-7
S-8
S-9
S-10
S-11
22
23
24
25
26

GREAT LAKES – ILLINOIS RIVER BASIN
COMPREHENSIVE STUDY

SOURCES OF POLLUTION –
INDUSTRIAL WASTES

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

FIGURE 7

TABLE 18
INDUSTRIAL WASTE SOURCES IN THE CHICAGO METROPOLITAN AREA TRIBUTARY TO THE ILLINOIS WATERWAY

(a) SOURCES IN THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

Map No.	PHS Industry Code	River Mileage	Effluent MGD	PE (5-Day BOD)
		NORTH BRANCH CHICAGO RIVER		
S-1	28C	I 325.6-2.0	4.08	1200
S-2		I 325.6-0.8	0.074	4500
seven other plants			0.860	1690
			5.014	7390
		ILLINOIS WATERWAY		
S-3	22E	I 321.6	0.185	7020
S-4	29E	I 317.4	0.17	1610
S-5	33E	I 313.3	1.137	1150
S-6	29E	I 313.3	0.174	2640
S-7	20P	I 313.3	0.378	17570
ten other plants			4.516	3830
			6.560	33820
		DES PLAINES RIVER		
four plants			0.734	920
		CALUMET-SAG		
S-8	20Q	I 303.4-25.1	0.109	1420
S-9	34I	I 303.4-24.1	0.440	2320
S-10	28B	I 303.4-21.5	1.476	1640
S-11	29A	I 303.4-13.3	27.6	21000
two other plants			0.045	210
			29.670	26590
Total Inside MSD			42.0	68720
(b) SOURCES OUTSIDE OF THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO				
		DES PLAINES		
21			0.081	900
22			28.0	35000
23			40.0	49000
24			1.7	8540
25			0.125	1790
seven other plants			0.415	1080
			70.321	96310
		DuPAGE		
eight plants			0.173	780
		NORTH BRANCH CHICAGO RIVER		
two plants			0.052	60
		CALUMET SAG		
26 (in Indiana)			8.0	18000
three other plants			0.033	230
			8.033	18230
Total Outside MSD			78.6	115380
GRAND TOTAL			120.6	184100

breweries, vegetable canneries, and creameries. None of these industries are represented in our inventory of the Metropolitan District except two meat packers (one of whom is not slaughtering) with a combined load of 340 PE.

Metropolitan Sanitary District Records

The Metropolitan Sanitary District of Greater Chicago has studied industrial waste effluents for about thirty years. Some 905 separate studies have been made. A few of these concern streams or outfalls serving industrial areas, but usually individual industrial plants discharging either to streams or sewer systems have been studied. Some have been investigated several times. It is estimated that 400 plants have been studied one or more times. The purpose of studying discharges to the sewer system has usually been to measure and eliminate materials such as oil and heavy metals that interfere with proper operation of the Sanitary District sewage treatment plants.

In almost all studies, samples are analyzed for the following constitutents:

Total organic plus ammonia nitrogen.
Ammonia nitrogen.
Five day BOD.
Total suspended solids.
Volatile suspended solids.
pH.

Other analyses are made as required at individual plants, such as hexane solubles, phenol, iron, heavy metals, or chemical oxygen demand.

Illinois Waterway Basin Outside Metropolitan Sanitary District

Significant known sources of industrial wastes in the Chicago area outside the Metropolitan Sanitary District have been included in Table 18. These data were obtained by review of existing records of the Illinois Sanitary Water Board and the Indiana Stream Pollution Control Board. These records indicate a present pollution load of 115,380 PE.

It should be understood that the reported data are subject to revision as more accurate information becomes available. It is planned to make engineering investigations of each major industry discharging directly either to the Illinois Waterway or to its tributaries. Cooperative industrial waste suveys will be conducted, as rapidly as possible, at those manufacturing plants believed to be contributing significant pollution loads.

RADIOACTIVE WASTES

A preliminary investigation of existing and potential radiological contamination of the Upper Illinois River Waterway was initiated. This consisted of identifying potential sources of radioactive wastes, assembling available information on existing levels of radioactivity in waste flows, collecting a limited number of samples for radio activity measurements, and analyzing the information to determine the extent of the problem and to identify areas requiring further study.

Significance of Radiological Pollution

Contamination of surface waters by radioactive materials can result in human radiation exposure in a variety of ways as indicated in Figure 8. The most direct and obvious manner is by ingestion as would occur if the particular body of water is used as a source of municipal water supply. Other less direct means would be through the consumption of fish or shellfish from a contaminated stream or agricultural crops irrigated by such water. Since the Illinois River is used as a source of municipal water supply by the City of Peoria, it is this mode of intake which is probably of major concern in this instance.

While it is generally agreed that all unnecessary human radiation exposure is undesirable and should be prevented, limiting standards for maximum permissible exposure have been recommended by the National Committee on Radiation Protection.(5) Such standards recognize the fact that some degree of man made radiation exposure is inevitable if the benefits of nuclear energy are to be fully realized. The existing standards, however, have been selected so that continuous lifetime exposure at these levels would result in what are believed to be negligible effects.

Using the limiting standards for human radiation exposure together with knowledge of the behaviour of specific isotopes in the body, the energy of their radiation, decay rate, and other factors, maximum permissible concentrations (MPC) in water for various isotopes which would conform to the limiting exposure standards have been determined for 264 different

38-a

Radioactive Wastes from Water to Man

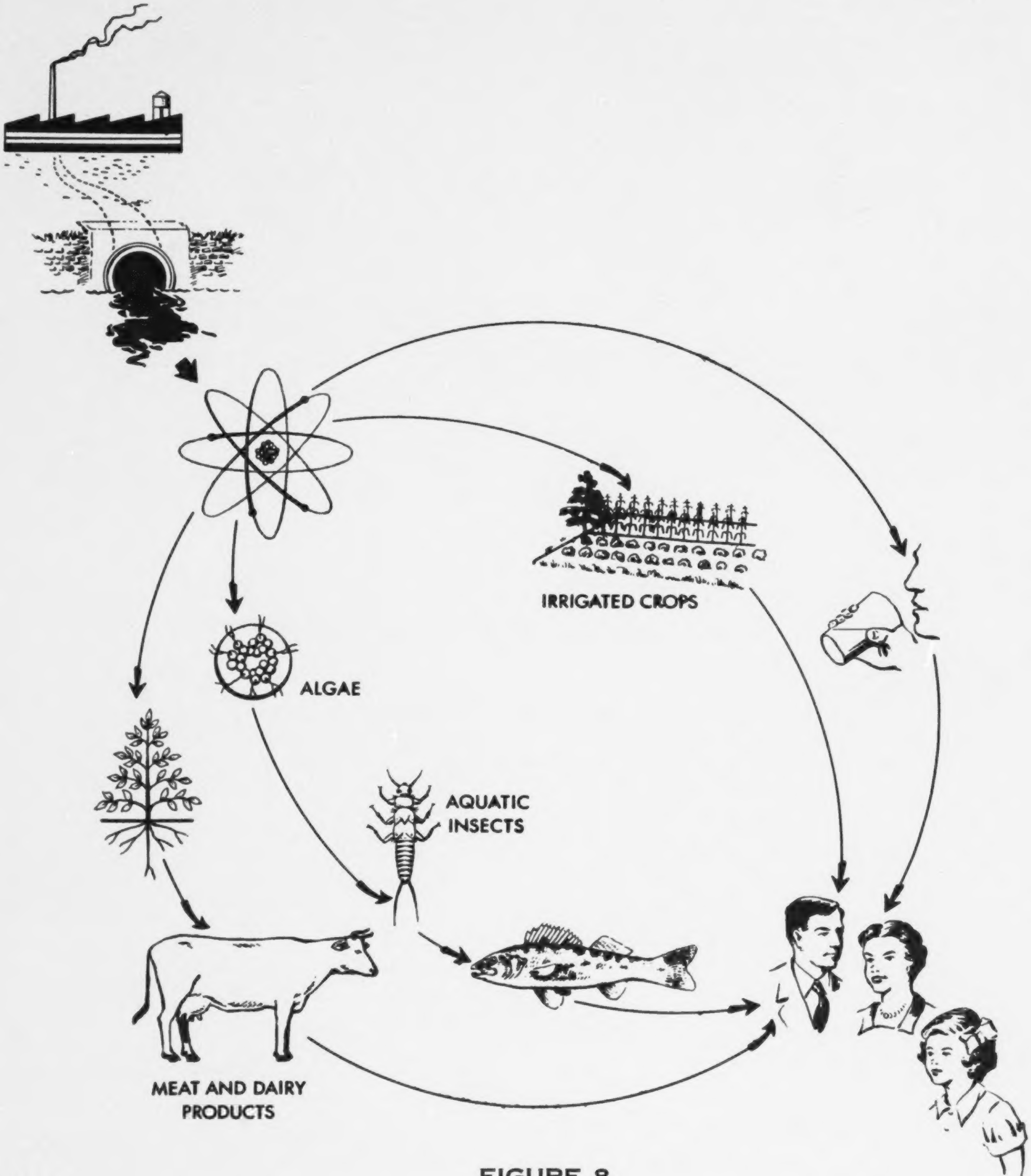

IRRIGATED CROPS
ALGAE
AQUATIC INSECTS
MEAT AND DAIRY PRODUCTS

FIGURE 8

TABLE 19
NUCLEAR REACTORS
ILLINOIS RIVER BASIN

Name	Type	Kw	Start Up
Argonne National Laboratory Lemont, Illinois			
Argonne Research Reactor (CP-5)	Heavy Water	5,000	1954
Experimental Boiling Water Reactor (EBWR)	Boiling Water	100,000	1956
Argonne Nuclear Assembly for University Training, Argonaut (CP-11)	Graphite/Water	10	1957
Argonne National Laboratory (AGN-201-108)	Homo. Solid	Neg	1957
Argonne National Laboratory (Juggernaut)	Graphite/Water	250	1961
Biological Research Reactor (JANUS)	Tank	200	1961
Armour Research Foundation Chicago, Illinois (ARR)	Homogeneous	50	1956
Dresden Nuclear Power Station (Commonwealth Edison Company) Morris, Illinois	Boiling Water	626,000	1959

Data from Reference 6 - USE OF WATER RESOURCES

radioisotopes.(5) Since these values vary tremendously (by as many as ten orders of magnitude) depending upon the radioisotope, it is necessary for precise evaluation of potential hazards to have knowledge of the particular isotopes involved. If, however, it is desired to perform merely gross evaluation to delimit the problem as is the case here, it is helpful to employ for comparative purposes, the maximum permissible concentration in water of unidentified radionuclides, or MPCU. This value quite naturally must be at least as low as the lowest value for the individual isotopes. Ra-226 has the lowest MPC at 3.3 uuc/l. (Average for the general population, or 1/30th the continuous occupational exposure value.) This then is also the MPCU. If radium is known to be present in negligible amounts, the MPCU may be adjusted upward to a value of 33 uuc/l., which is the MPC for the next most hazardous isotope, Sr-90. Similarly, if neither Ra-226 nor Sr-90 is present, the appropriate MPCU becomes 233 uuc/l. These values, then, may serve as a frame of reference for the discussions which follow.

Sources of Radioactive Wastes

Potential sources of radioactive wastes which could reasonably be expected to find their way into the waters of the Illinois Waterway can be grouped in two categories: a. nuclear reactors or other special installations, and b. radioisotope users. The former is by far the more significant from the standpoint of potential radiological water pollution. There are three installations in this category in the area of concern: the Argonne National Laboratory, Lemont, Illinois; the Dresden Nuclear Power Station, Morris, Illinois; and the Armour Research Foundation, Chicago, Illinois. Data on the nuclear reactors at these locations are given in Table 19.

TABLE 20
ARGONNE NATIONAL LABORATORY LIQUID WASTES
JULY 1, 1955 TO JUNE 30, 1956

Type of Activity	Activity Discharged	Ave. Concentrations(a)
Alpha Emitters	13.7 mc.	18. μμc/l.
Beta Emitters (excl. Sr-90)	135. mc.	180. μμc/l.
Sr-90	0.42 mc.	0.56 μμc/l.

(a) Total liquid discharged = 198 Million gallons.

Data from Reference No. 7 - USE OF WATER RESOURCES

Argonne National Laboratory

The Argonne National Laboratory is a research and development laboratory which is operated by the University of Chicago under contract for the Atomic Energy Commission. Due to the broad scope of research activities, many being associated with nuclear reactor fuels, in addition to the operating reactors shown in Table 19, significant quantities of liquid radioactive wastes are produced. The laboratory is equipped with a large well-designed and operated waste treatment facility which has been described in detail elsewhere.(7,8) A conception of the magnitude of radioactivity discharged from this installation after treatment can be gained from the data in Table 20. Since radium and strontium are reported to be discharged in quantities which are not significant as compared to their MPC values, it would seem that the liquid wastes from the Argonne National Laboratory on the average meet the previously discussed limiting MPCU values for continuous human consumption.

Treated effluents from the Argonne National Laboratory are discharged to Sawmill Creek about 500 yards above the point where the Creek empties into the Des Plaines River.(9) Table 21 shows the effect of the discharge on already existing levels of radioactivity in both Sawmill Creek and Des Plaines River. It can be seen that the effect of the discharge is detectable in Sawmill Creek waters. An average increase in alpha activity of about 10 μμc/l. occurs, essentially all of which is due to natural uranium in the discharge. The uranium, plutonium, and thorium concentrations in Sawmill Creek below the outfall are but 0.2, 0.02, and 0.3%, respectively, of their MPC values. Beta activity both above and below the outfall reflected the presence of fission products from nuclear weapons tests, while samples taken below the site showed an average increase due to wastes of 10 μμc/l. All of the individual beta emitter concentrations shown in Table 21B including Sr-90 are very greatly less than their MPC levels. Data in Table 21C indicate that the radioactivity of Sawmill Creek has little or no effect on the Des Plaines River activities present above their confluence due to the dilution provided. In general then, under normal operating conditions the radioactivity added to the aquatic environment by the Argonne National Laboratory is not significant at the present time.

Dresden Nuclear Power Station

The Dresden Nuclear Power Station, located 47 miles southwest of Chicago at the confluence of the Kankakee and Des Plaines Rivers, is the Nation's largest, all-nuclear, power plant. It was financed entirely by private industry, and is owned and operated by the Commonwealth Edison Company in association with several other major utilities, collectively named the Nuclear Power Group, Inc. Dresden is a dual cycle boiling water reactor employing 145,000

TABLE 21
RADIOACTIVITY LEVELS
ENVIRONS OF ARGONNE NATIONAL LABORATORY
1958 AVERAGE VALUES (μμc/1.)

A. NONVOLATILE ALPHA ACTIVITY SAWMILL CREEK WATER

Location	Gross Alpha	Uranium	Plutonium	Thorium
Above ANL Site	2.8	2.1		0.1
Below ANL Site	13.4	13.0	0.4	0.1

B. BETA ACTIVITY SAWMILL CREEK WATER

Location	Total	Sr-90	Sr-89	Ce-141	Ce-144	I-131	Ba-140
Above ANL Site	26.9	0.4	11.4	18.7	0.7	1.3	1.5
Below ANL Site	36.	2.5	5.8	25.	0.6	0.5	0.4

C. NONVOLATILE RADIOACTIVITY DES PLAINES RIVER WATER

Location	Gross Alpha	Uranium	Gross Beta
2.5 miles above Sawmill Creek	1.9	1.4	39.9
0.5 miles below Sawmill Creek	1.9	1.5	43.4

Data from Reference No. 9 - USE OF WATER RESOURCES pounds of U-238 (as uranium dioxide) as nuclear fuel enriched by 1.5% U-235.(10) Construction of the plant was completed in 1960 and power testing operations began in April of that year. The Atomic Energy Commission authorized full power operations in October. The reactor was shut down one month later because of operating difficulties. In April of 1961 the station was authorized on line at a 100 kw power level.

The principal sources of soluble radioactive wastes in such a reactor are neutron-activation products of reactor system materials and the leakage of fission products released from the reactor fuel through defects in the fuel rod container walls. Neutrons which do not collide with fissionable materials travel relatively long distances, and are absorbed by the coolant, the impurities which it contains and by structural elements, causing the formation of radioactive isotopes of the absorbing media.

While the sources of liquid radioactive wastes within the plant are many and varied, they are for the most part intermittent in nature, the only continuously flowing wastes being from the secondary steam generator blowdown. As liquid wastes are generated they are collected and analyzed to determine appropriate treatment either by storage for decay of short-lived activity, filtration and demineralization for low solids wastes, evaporation for high solids wastes, or long-term storage for the small volume of higher activity wastes from other treatment steps. To the extent possible, treated liquid wastes are recycled for further use within the plant.

Liquid wastes discharged from the plant after treatment average 5,000 to 7,000 gallons daily with a residual activity discharge averaging 30 mc/day. This discharge is added to the 163,000 gpm cooling water flow before discharge to the Illinois River just below the point where it is formed by the Kankakee and Des Plaines Rivers. Based on the average figures an average discharge activity of about 35 μμc/l. would result. Station operating records indicate the actual concentrations discharged thus far range from 5 to 25 μμc/l.

The permissible waste discharge from the reactor was established by a permit issued by the Illinois State Sanitary Water Board on August 15, 1960. The maximum discharge activity concentration allowed under the terms of this permit is variable and is dependent upon concentrations observed in the Illinois River below the station at Morris, Illinois. Permissible discharge concentrations are computed each month for the following month by the State as shown in Table 22 wherein the discharge concentration permitted is 100 μμc/l. minus the preceding 12 month average concentration observed downstream at Morris. Thus, the discharge is somewhat self-regulated whereby increases in activity discharged will result in a lowering of the permissible discharge level so that a concentration of 100 μμc/l. at Morris will never be exceeded. Thus far the actual activity levels of the waste discharge as reported to the State Department of Public Health have been only 10 to 20% of the maximum amount permitted.

The Illinois Department of Public Health has been monitoring radioactivity levels starting in 1958 at upstream points in the Chicago Sanitary and Ship Canal, Des Plaines and Kankakee Rivers, and downstream in the Illinois River at Morris and Marseilles. Only trace amounts of alpha activities have been found and beta activities have fallen steadily from the high levels (up to several thousand μμc/l.) occurring in 1958 as a result of nuclear detonations. Average range of values during 1960 was below 10 μμc/l. at all points.

It is expected that 1.1 million gallons of radioactive liquid waste will be discharged annually at rated capacity with 1.5 to 2 million gallons being treated for reuse.(7) About 0.2 million gallons consisting of regenerant solutions from the condensate demineralizer system and decontamination and laboratory waste solutions will be concentrated by evaporation with the concentrate being stored in a steel tank housed in an underground concrete vault. Up to 1,200 curies of activity may be contained in this concentrated solution. The accidental release of this amount of stored material, an extremely remote if not non-existent possiblity, would of course, result in very high levels in the Illinois River. At a flow of 5,000 cfs with release over a one day period, for example, activity levels of 10^5 μμc/l. would result. Lower flows and shorter release times would yield proportionately higher concentrations in the river. While certainly high, these levels would be of short duration and, assuming notification would be given to downstream water users, little actual damage would ensue.

It can be concluded that under normal operating procedures the radioactivity added to the

TABLE 22
PERMISSIBLE ACTIVITY DISCHARGE CONCENTRATIONS FROM DRESDEN NUCLEAR POWER STATION TO ILLINOIS RIVER

Month	Gross Beta Activity (μμc/l)	
	Average at Morris, Ill. For 12 Months Preceding Months Shown	Maximum Allowable Concentration for Dresden NPS Discharge For Month Shown
April 1961	5.2	94.8
March	5.6	94.4
February	5.8	94.2
January	5.1	94.9
December 1960	6.3	93.7
November	6.6	93.4
October	7.0	93.0
September	8.3	91.7
August	8.2	91.8
July	11.9	88.1
June	16.4	83.6
May	18.6	81.4
April (Operation Tests begin)	25.8	74.2
March	32.7	67.3
February	31.0	69.0
January	31.4	68.6
December 1959	32.1	67.9

Analyses conducted by Department of Public Health Laboratory, Chicago, Illinois.

Illinois River by Dresden will be well within the limits presently considered acceptable.

Armour Research Foundation

This reactor is a homogeneous solution type of low (50 kw) power level which is used for industrial research.(11) It is located in a high population density area in the City of Chicago five miles south of the Loop and two miles west from the lake shore. The reactor fuel consists of 850 gms of U-235 in a 95 mg/l. solution as uranyl sulfate. Continuous fission product removal from the fuel solution external to the reactor is required in such homogeneous systems. Storage of high level liquid wastes from reactor maintenance operations is practiced. Since decay is not sufficient for disposal at the site these wastes are placed in five-gallon plastic-lined steel containers filled with vermiculite and shipped to the Argonne National Laboratory for disposal. Low level wastes are collected in two 1,200 gallon stainless steel tanks and after analysis are discharged to the City of Chicago sewer system. Past records indicate an average activity discharge of 10 mc/yr. of beta emitters with only trace amounts of alpha activity. The reactor cooling system is a closed recirculation type using distilled water. Low induced activities in the cooling

TABLE 23
UNSEALED ISOTOPE USE
CHICAGO, ILLINOIS

Type and Number of Users		Amt. of Activity on Hand (Curies)	Est. Annual Use (Curies)	Isotopes Used
Industry	20	35.9	55.1	H-3; C-14; Na-22, 24; P-32; S-35; Cl-36; K-42; Ca-45; Cr-51; Fe-55, 59; Co-60; Ni-63; Zn-65; Sr-85, 90; Zr-95; Ag-110, 111; I-125, 131; Cs-137; Pm-147; Au-198; Tl-204; Bi-206, 210; Pb-210; Ra-226; Th-232; U-238.
Medical	29	26.2	40.2	
Educational	5	12.4	14.2	
Total	54	74.5	109.5	32

water are removed by ion exchange equipment. Under normal operating conditions no radioactive effluents are continuously produced.

The reactor is housed below the level of the sewer system and all discharges must be pumped to waste. Thus, even under emergency conditions, good control of waste discharges is available.

Radioisotope Users

The production and distribution of radioisotopes has climbed steadily since they first became generally available in 1946. These materials are used under AEC licensing regulations for medical, industrial, and educational purposes. Most of the more than one million curies(6) distributed to date by the AEC from Oak Ridge are used as sealed sources for such purposes as medical teletheraphy, industrial radiography, thickness, density and level gaging, while some isotopes are incorporated during manufacture of devices such as electron tubes, static eliminators, etc. It is estimated that over 97% of the total isotope activity shipped is used in this manner.(7) This radioactive material is sealed in such a manner that leakage of material would not be expected. As such they do not represent waste problems until the end of their useful life and then as solid waste material. The bulk of remaining isotopes in use have half lives of less than 30 days and are used chiefly in medical diagnosis and therapy as well as in industrial development and research applications. Some percentage of this material can be expected to find its way to liquid waste streams; however, the amount would be small.

Since all isotope users are licensed by the AEC, a review of such licenses on file at Illinois State Department of Health was carried out to determine the magnitude of potential wastes from this source. It was found that of approximately 250 licenses in Illinois almost half were located in Chicago. Further, about one half of the Chicago licenses were for material in sealed sources. The remaining unsealed radioisotopes use in Chicago is summarized in Table 23. It can be seen that significant amounts of radioisotope activity are in use in this manner.

It is not possible to determine from such information, however, what radioactivity concentrations could be expected in Chicago municipal sewage from radioisotope use. This is primarily because some large unkown fraction of the activity shown never reaches the sewer system since it may be incorporated in some manufactured device, allowed to decay

TABLE 24
RADIOACTIVITY IN CHICAGO WATER SUPPLY AND SEWAGE EFFLUENTS

Sample Source	Date of Sample	Total Diss. Solids (ppm)	Alpha (μμc/l)			Beta (μμc/l)		
			Diss.	Susp.	Total	Diss.	Susp.	Total
Tap Water Calumet STW	5-15-61	98	0.61	0.10	0.71	7.4	0.64	8.0
Calumet STW Effluent	5-15-61	748	0.44	0.15	0.59	30.	2.0	32.
	6-5-61	726	1.4	0.10	1.5	16.	0.56	17.
Northside STW Effluent	5-15-61	438	0.55	0.22	0.77	14.	1.7	16.
	6-5-61	461	0.92	0.084	1.0	19.	0.63	20.
WSW-STW Effluent	6-5-61	551	1.1	0.44	1.5	14.	3.7	18.

prior to disposal, injected into a patient from whom it is eliminated slowly or after significant decay, or for a variety of other reasons. A gross estimate of possible waste stream concentrations may be obtained by assuming: (1) that all activity used reaches the sewer at full strength; and (2) that annual usage is uniform throughout the year. Under these extreme conditions an approximate activity concentration in Chicago sewage due to radioisotope use of 200 μμc/l. would result. For reasons enumerated above a considerably lower concentration would actually be expected, if indeed, any evidence of their presence could be detected at all.

In order to obtain some indication of the effect of radioisotope use in Chicago on the amount of radioactivity added to the Illinois Waterway by that city's liquid wastes, samples were taken of treated sewage effluent from each of Chicago's three major treatment works. In addition, a drinking water sample (filtered Lake Michigan water) was taken simultaneously. All samples were collected over a 24-hour period and composited prior to analysis. All were collected on a weekday. Analyses performed on these samples included gamma spectrum analysis and gross alpha and beta radioactivity measurements on both suspended and dissolved fractions of the samples.

The gamma energy spectra for all were essentially identical indicating that none of the gamma emitting radioisotopes reported in use were present in the city's sewage to a degree which permitted detection. The spectra obtained on all samples were quite similar to typical unpolluted waters containing only background levels of radioactivity. The gross radioactivity counts on the same samples which are given in Table 24 allow similar conclusions to be drawn. The alpha activities found in the water supply and sewage effluents are not significantly different. However, slightly higher beta levels were found in the sewage effluent samples. This observed increase can be attributed to the much greater dissolved solids content of the sewage as compared to the water supply. The activity contained in the water supply and sewage dissolved solids is comparable, but since there are four to seven times as many solids in a liter of sewage as in the same volume of lake water the activity of the sewage on a volume basis can be expected to be higher. It can be concluded, therefore, that radioisotope usage in Chicago was not readily detectable in that city's waste effluents during the brief period represented by these samples. While sampling over a considerably longer period of time would be required to establish definitely the amount of radioactivity added to the water during use in the city, it is doubtful that a significantly different conclusion would be reached.

STORM WATER

Underground storm water drainage in Chicago was inaugurated with the construction of the first city sewer system in 1856. The system was designed to carry both storm water and sanitary sewage to the Chicago River and to Lake Michigan, and served about seven square miles including the present "Loop" area. In the 105 years since 1856, the Chicago combined sewer system has been expanded to include over 3,600 miles of sewers serving 214 square miles with 3.5 million population. Most of the suburban municipalities in the Chicago Metropolitan Area also are served by combined sewer systems which discharge storm runoff into the waterways of the area.

For many years these combined sewers discharged all flows direct to the streams, of which some were tributary to Lake Michigan, and others tributary to the Illinois River. In 1890, the Metropolitan Sanitary District of Greater Chicago was organized and initiated construction of a system of sanitary and combined interceptor sewers serving Chicago and many of the suburbs. The interceptor system is designed to conduct dry weather flows to the various sewage treatment plants operated by the Sanitary District, and to discharge storm runoff through overflow structures and pumping stations, to the Des Plaines, Chicago and Calumet Rivers, the Chicago Sanitary and Ship Canal, and the Calumet-Sag Channel.

Storm water overflows to the Des Plaines River follow the natural course of the river to the Illinois River. Storm water overflows to the Chicago River are also tributary to the Illinois River, since the natural direction of flow of the Chicago River has been reversed. The Calumet-Sag Channel, completed in 1922 by the Sanitary District, was designed to reverse the flow of the Calumet River from Lake Michigan to the Chicago Sanitary and Ship Canal. This flow is regulated by means of the Controlling Works at Blue Island, except during infrequent heavy storms when runoff threatens to cause flood damage along the Calumet-Sag Channel. At such times, the control gates are closed, forcing Calumet River flood flows to Lake Michigan. If storm runoff to Calumet-Sag Channel causes the water surface to rise above that of the Calumet River, the control gates may be opened to permit flow out of the Calumet-Sag to Lake Michigan, as a flood relief measure. Thus, storm water overflows to the Calumet-Sag Channel and Calumet River are usually tributary to the Illinois River but may occasionally go to Lake Michigan. A new lock and control gates have been built in the Calumet River just downstream from the confluence of the Grand Calumet and Little Calumet Rivers. After removal of the old Controlling Works, Calumet-Sag Channel flows will be regulated at the new lock.

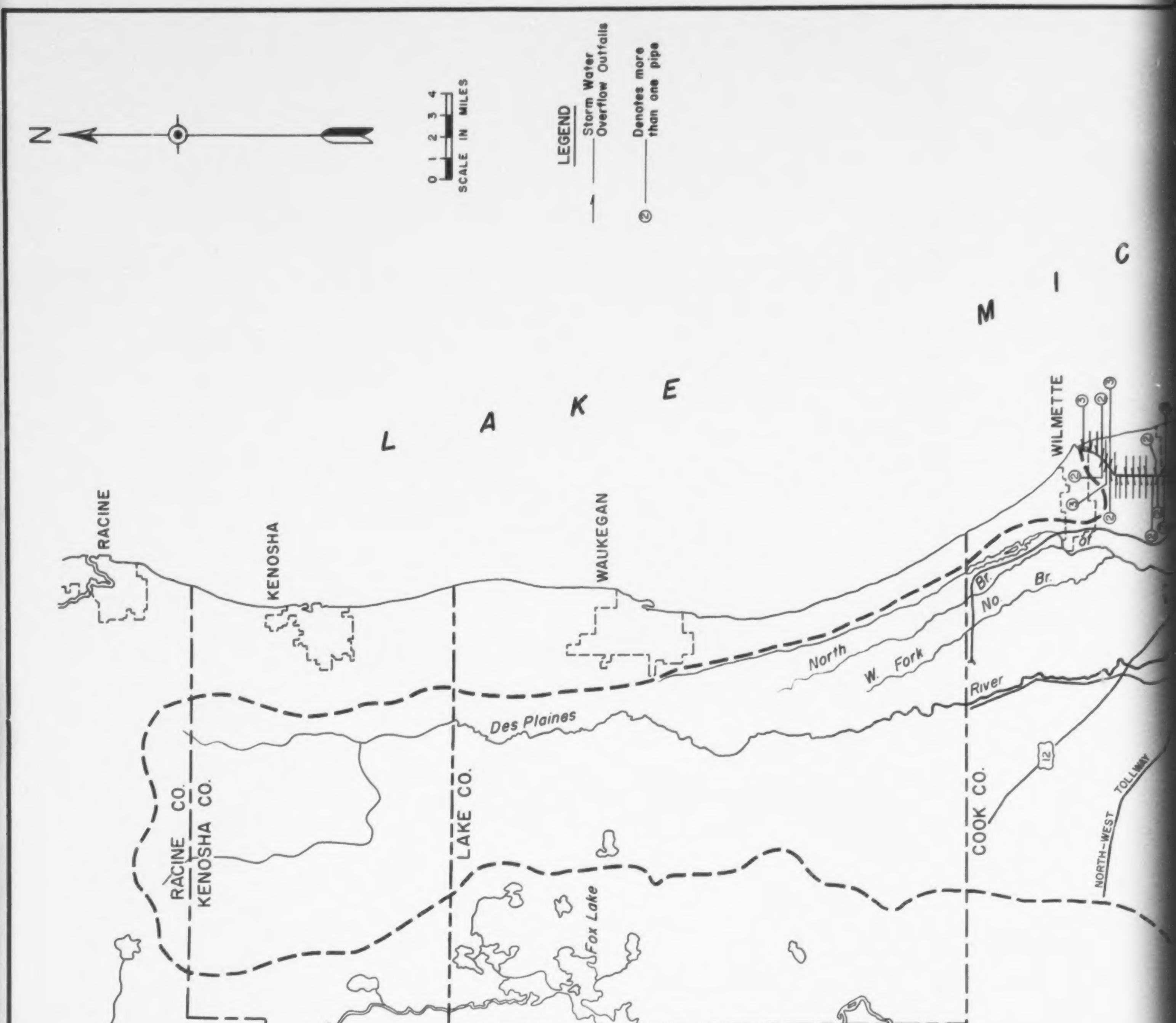
Pollutional Aspect of Storm Water Overflows

The discharge of raw sewage and industrial wastes mixed with storm water during periods of storm runoff constitutes a major intermittent source of pollution of the waterways in the Chicago area. The physical extent of the problem is indicated by the large number of overflows, approximately 200 on the main channels, and an undetermined number on tributary streams such as Des Plaines River, North Branch Chicago River and Little Calumet River. The locations of the overflows on the main channels are shown on Figure 9 to the extent of the information available at this time.

Pollution of streams in a Metropolitan area results in economic loss through curtailment of recreational use of the waterways, increased water treatment costs, reduced property values, corrosion of boats and nearby structures, and, under certain conditions, the loss of industrial development. The esthetic value of the streams is destroyed by unsightly floating material, murky waters and unpleasant odors. The biological life of the stream is adversely affected by low oxygen values resulting from the oxygen demand of sewage and industrial wastes. Pleasure boat operators either avoid the waterways or use them as a means of access to less polluted waters.

More important, however, is the danger to public health from the pathogenic bacteria and viruses which may be present in raw sewage. Although the concentration of BOD and sewage solids, with exception of the first flush, may be reduced by dilution during runoff periods, the pathogens remain a serious menace to any public use of the streams.

GPO 812422—14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SCALE IN MILES
LEGEND
Storm Water Overflow Outfalls
② Denotes more than one pipe
LAKE MIC
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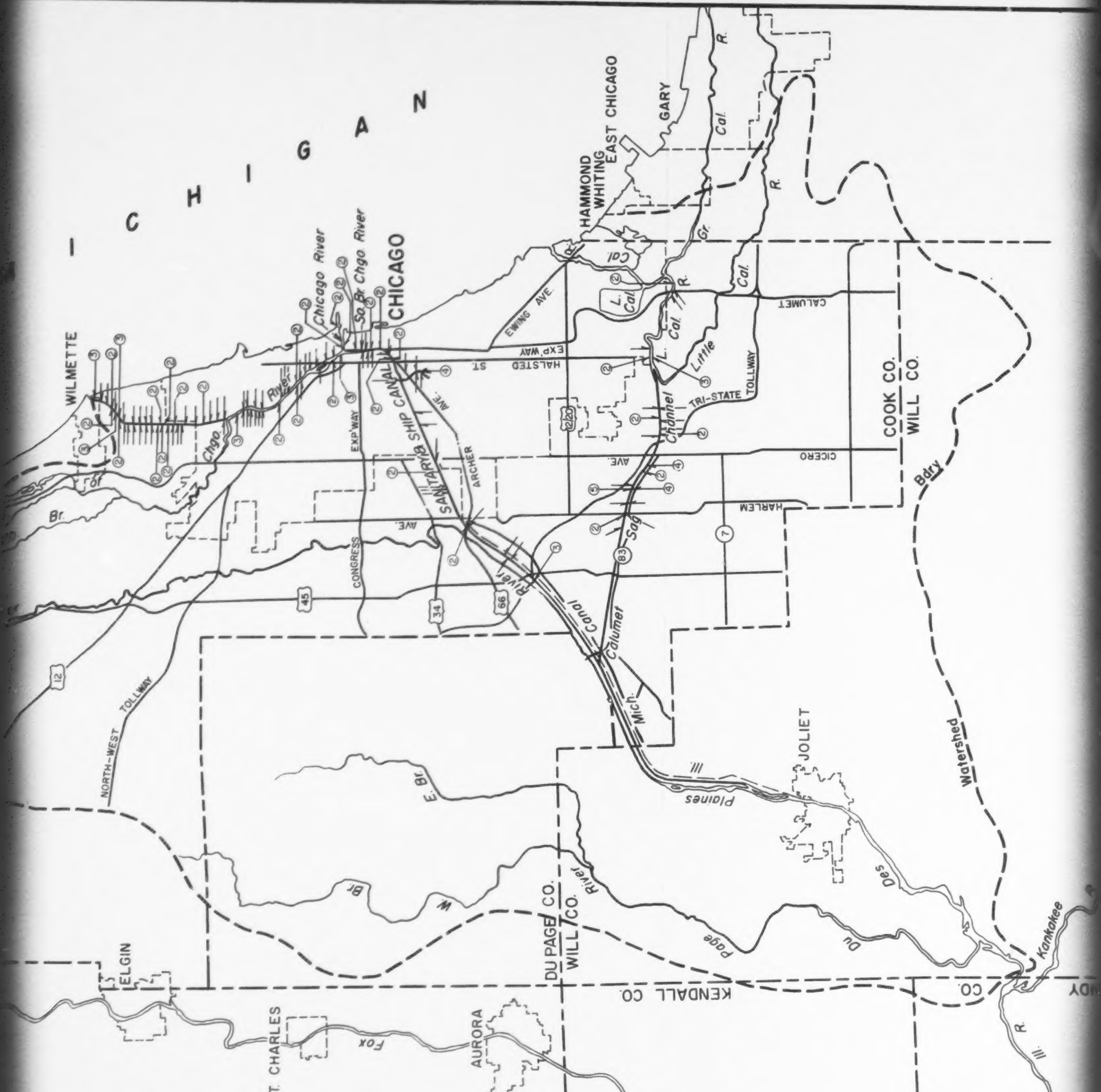
North
W. Fork
No. Br.
Br. of
River
Des Plaines
Fox Lake
River
RACINE CO.
KENOSHA CO.
LAKE CO.
COOK CO.
McHENRY CO.
WISCONSIN
ILLINOIS
WALWORTH CO.
KANE CO.
ELGIN
12
NORTH-WEST TOLLWAY


I C H I G A N
WILMETTE
CHICAGO
Chicago River
So. Br. Chgo River
Chgo. River
Br.
HAMMOND
WHITING
EAST CHICAGO
GARY
Cal. R.
Gr. Cal. R.
L. Cal.
L. Cal.
Little Cal.
EWING AVE.
CALUMET
HALSTED ST.
EXP'WAY
TRI-STATE TOLLWAY
Calumet Sag Channel
CICERO AVE.
HARLEM AVE.
ARCHER AVE.
SANITARY & SHIP CANAL
CONGRESS EXP'WAY
COOK CO.
WILL CO.
Bdry
Watershed
83
7
45
34
66
12
120
River
Canal
Calumet
Mich.
Ill.
Des Plaines
NORTH-WEST TOLLWAY
JOLIET
E. Br.
W. Br.
Du Page River
DU PAGE CO.
WILL CO.
KENDALL CO.
CO.
Kankakee
Ill. R.
ELGIN
ST. CHARLES
AURORA
Fox
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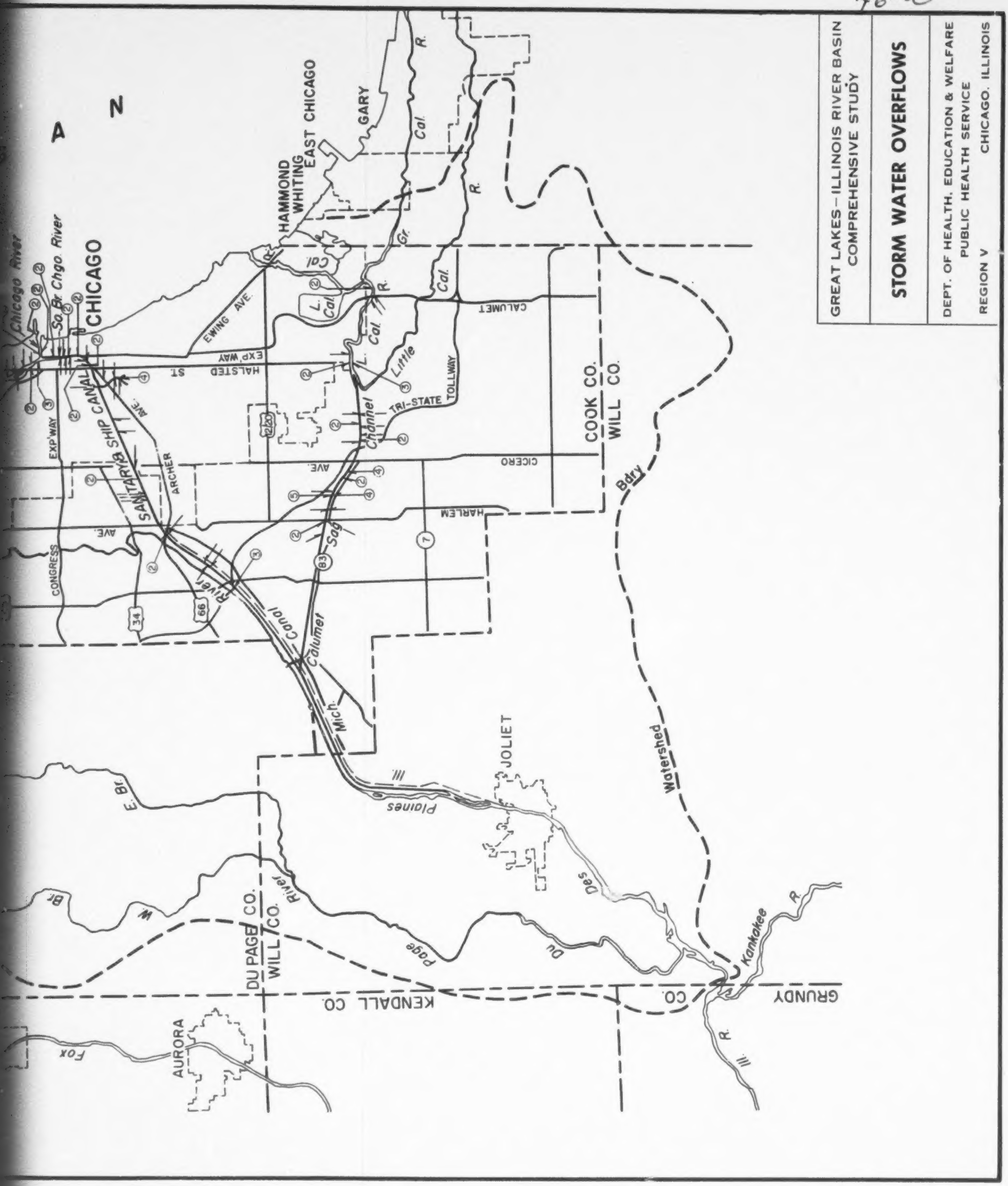
3
4

46-a



GREAT LAKES – ILLINOIS RIVER BASIN
COMPREHENSIVE STUDY

STORM WATER OVERFLOWS

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V CHICAGO, ILLINOIS

A N
Chicago River
So. Br. Chgo. River
CHICAGO
HAMMOND
WHITING
EAST CHICAGO
GARY
Gr. Cal. R.
Cal. R.
Cal.
L. Cal.
Little Cal.
EWING AVE.
EXP'WAY
HALSTED ST.
CALUMET
TOLLWAY
TRI-STATE
EXP'WAY
SANITARY & SHIP CANAL
ARCHER AVE.
CICERO AVE.
HARLEM
CONGRESS
AVE.
Cal. Sag Channel
Calumet
83
7
34
66
Ill. Mich. Canal
River
COOK CO.
WILL CO.
Watershed Bdry
JOLIET
Des Plaines
Ill.
E. Br.
W. Br.
Du Page River
DU PAGE CO.
WILL CO.
KENDALL CO.
GRUNDY CO.
Kankakee R.
Ill. R.
AURORA
Fox

FIGURE 9

GPO 812422—15

The total pollution load contributed to Chicago area watercourses by storm water overflows from the combined sewer systems has not been determined by field measurement. The percentage of the annual sanitary and industrial waste flow spilled to the canals during overflows has been estimated by several investigators to be in the range of three to five percent for sanitary sewage interceptors designed for one and one half to three times the average dry weather flow. However, the first slug of such wastes may be several times the strength of the normal sewage flow.

In 1947, J.E.McKee(12), reporting on studies for sewage disposal in the Merrimack River Valley Sewerage District in Massachusetts, showed that, although only a small percent of the annual sanitary sewage flow is lost in storm water overflows, a large percent of the sewage present in the combined sewers during rainstorms is lost during overflows. McKee's studies also showed that with interceptors designed for one and one half to three times the average dry weather flow, overflows will occur every five or six days on the average during summer months. Thus the receiving stream would be seriously polluted for short but frequent periods during rainstorms, which would greatly restrict the recreational use of the stream.

McKee's study also showed that increasing the capacity of the interceptors for the purpose of reducing the frequency of overflows sufficiently to avoid pollution of recreational waters was not economically feasible. Studies reported by C.L. Palmer(13) for Detroit, Mich., C.F. Johnson(14) for Washington, D.C., T. R. Camp (15) for Concord, N.H., W. W. Horner(16) for St. Louis, Mo., and S. A. Greely and P. E. Langdon(17) for New York City have supported the findings of McKee.

The public health problem of pathogens in mixed sewage and storm water was emphasized by Camp(18) in a report of studies of chlorination of raw sewage for bacteria kills and virus inactivation.

Remedial measures for the abatement of pollution resulting from storm water over flows must be based on a study of the individual problem. Complete separation of the sanitary sewage from storm runoff, accomplished by construction of a new sewer system of sanitary sewers, would prevent stream pollution by sanitary sewage. In the Chicago area, the cost of a new sewer system, even when considered over the period of time required for construction, would be very high. However, consideration should be given to a policy similar to that now in effect in Washington, D. C., which requires that all new buildings shall have separate sewage systems. The city may then begin a program of separate sewer construction serving new residential areas, redevelopment projects, industrial parks, and ultimately the established areas, which would eventually lead to complete separation of all sewers. Although this program may require 50 years or more to reach a point at which it would be considered feasible to complete the separation by constructing the connecting links, alternate solutions proposed for problems of this type would be only partially effective.

At the other extreme, the solution of the problem would consist of complete treatment of all combined sewage. This would involve construction of additional interceptors and treatment plants, also at great expense. A modification of this method which would provide complete treatment of dry weather flow and primary treatment of overflows would require construction of storm water treatment facilities. Such a system was proposed by Greeley and Langdon(17) for New York City, with retention basins designed to prevent the discharge of floating sewage solids, and to provide an adequate contact time for effective chlorination. Camp(18) recommends chlorination of storm water to prevent pollution by bacteria and viruses, estimates that a chlorination capacity of about ten times that required for dry weather flow should be adequate for most installations.

A comprehensive study of the Chicago problem will be required to determine what combinations of the above methods would be most effective, and economically feasible. The study would involve extensive sampling and flow measurement necessary to obtain data representative of all contributing areas. Only after analysis of these data could the effects on the streams of various plans for polllution abatement be predicted with safety. These studies would take considerable time to complete, but in view of the construction costs which would be involved in any recommended plan covering the Chicago Metropolitan Area, the studies would be fully justified.

INVESTIGATION OF WATERWAY POLLUTION

PHYSICAL CHARACTERISTICS

The portion of the Illinois Waterway studied is a unique combination of natural watercourses and artificial channels (Figure 2). Both the natural watercourses and the artificial channels have been excavated, dredged, and, in some sections, lined to make them suitable for navigation. The direction of flow in some of the natural watercourses has been reversed. Control works have been provided at both the upper and lower ends of the system.

The northern end of the system is at Wilmette, where water is diverted from Lake Michigan through control works into the artificial North Shore Channel. About four miles below the point of diversion the North Shore Channel receives the effluent from the Northside Treatment Works of the Metropolitan Sanitary District of Greater Chicago. This treatment works, as well as the two other major treatment works of the Sanitary District, employs the activated sludge process for sewage treatment. About 3.5 miles below the Northside Treatment Works the North Shore Channel joins the North Branch Chicago River. The Channel has been dredged to depths in the range of 8 to 10 feet.

The North Branch Chicago River flows about 7.5 miles from its confluence with the North Shore Channel to join the Chicago River near the Northeast corner of the Loop. The North Shore Channel-North Branch Chicago River System accounts for an average annual lake diversion of about 400 cfs, and carries about 380 cfs of sewage treatment plant effluent from the Northside Works. The North Branch between its confluence with the North Shore Channel and the Chicago River has been dredged to depths ranging from about 10 to 21 feet.

The Chicago River, with its natural direction of flow reversed, draws water from the lake through the Chicago Harbor Controlling Works and conveys it a little over a mile to the confluence with the North Branch.

At this confluence the combined flow enters the South Branch Chicago River, with its natural direction of flow also reversed. After flowing approximately four miles in the South Branch the water enters the Chicago Sanitary and Ship Canal. The Chicago River-South Branch System accounts for an annual average lake diversion of about 500 cfs.

A little less than six miles below its junction with the South Branch Chicago River, the Chicago Sanitary and Ship Canal receives the effluent from the Sanitary District's Stickney Treatment Works, the largest of the District's Sewage Treatment Plants. The average annual discharge of treated effluent from this plant is about 1,330 cfs.

About 12.5 miles below the Stickney Works the Chicago Sanitary and Ship Canal is joined by the Calumet-Sag Channel.

Flow in the Calumet-Sag Channel starts with diversion of lake water at Calumet Harbor. The diverted water passes down the former channel of the Calumet River, with its natural direction of flow reversed, for about 7.5 miles to its confluence with the Grand Calumet River. Here the water enters the former channel of the Little Calumet River, with its natural direction of flow also reversed. About six miles below its confluence with the Grand Calumet River the Little Calumet River enters the artificial Calumet-Sag Channel.

The Calumet-Sag Channel flows about 16 miles to its confluence with the Chicago Santary and Ship Canal. About 0.2 miles below its upper end the Channel receives the effluent from the District's Calumet Treatment Works. Stream discharge in the Calumet-Sag Channel, including diversion of lake water, is governed largely by lockage requirements at

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Blue Island Controlling Works near the upper end of the Channel. The Channel has been dredged to depths ranging from about 10 to 25 feet and is being widened along its lower end.

The Calumet-Sag Channel-Calumet Rivers System accounts for an average annual lake diversion of about 600 cfs. The Little Calumet River reach of the System receives an annual average of about 180 cfs of treated effluent from the Calumet Treatment Works.

Below its confluence with the Calumet-Sag Channel, the Chicago Sanitary and Ship Canal continues for about 12.5 miles to Lockport Lock and Dam after passing through Lockport Pool. The water level of the pool is maintained by a butterfly dam and sluice gates in the pool about two miles above the lock and dam. The level in the pool affects the level of the waterway upstream to the control works through which lake water is introduced into the system, with less than one foot of head between the pool level and water levels at the upper end of the Chicago River. The Canal has been dredged to depths in the range of about 17 to 26 feet with a depth of nearly 40 feet at the dam in Lockport Pool.

The Lockport Pool is the point of control for both stream discharge and water quality by the Sanitary District. It is here that stream flow is measured to assure compliance with the Supreme Court's decision limiting lake diversion to an annual average of 1,500 cfs.

Dissolved oxygen (DO) and biochemical oxygen demand (BOD) are determined regularly at this point by the Metropolitan Sanitary District as an index of the effectiveness of the District's waste control measures. Only limited water quality measurements have been made in the waterway upstream from Lockport.

A portion of the water from Lockport Pool is used for locking navigation craft through the lock.The remainder of the water, except for that lost by spillage during heavy rainfall and runoff by leakage, passes through turbines to generate power for the Sanitary District. Below the power house the Chicago Sanitary and Ship Canal continues downstream for about one mile to its confluence with Des Plaines River in the upper end of Brandon Road Pool.

Below this confluence the water flows in the channel of the Des Plaines River. From Lockport Lock and Dam to Brandon Road Lock and Dam the river flows for five miles through the Brandon Road Pool.

Below the Brandon Road Lock and Dam the water flows through Dresden Island Pool for about 14.5 miles to Dresden Island Lock and Dam. About 1.5 miles above the dam, the Kankakee River joins the Des Plaines River to form the Illinois River which then flows 273 miles to the Mississippi River.

HYDRAULIC CONTROL OF THE WATERWAY

The Sanitary District is responsible for the day to day hydraulic control of the waterway from Lake Michigan to Lockport. The District is limited ,by Supreme Court decision, to an annual average lake water diversion, exclusive of municipal water supply pumpage, of 1,500 cfs. The allowable diversion includes an annual average of about 500 cfs of runoff to the waterway which would flow to thelake if the natural direction of flow of the streams involved had not been reversed. Another restriction is that the books of the District on diversion must be balanced at the end of each calendar year. This restriction operates to minimize the most effective use of dilution water available during calendar years of high rainfall and runoff. During such years it would be advantageous if the District could make maximum use of dilution by the runoff from surface areas formerly tributary to the lake and minimum use of direct diversion water. The resulting reduced use of lake water would be of benefit to the District only if credit for such reduction could be carried forward to and used during some subsequent year when rainfall and runoff were below normal. More nearly uniform dilution from year to year could be achieved if the District were required to balance the books on diversion over a period of several years rather than each year.

Total stream flow in the watercourse is measured at Lockport. Here, as noted previously, a portion of the flow is passed through turbines to generate hydroelectric power. The objective for control of total flow at Lockport for each month of the year is as follows:

Month	cfs	Month	cfs
January	3,150	July	3,600
February	3,150	August	3,400
March	3,300	September	3,400
April	3,900	October	3,300
May	3,800	November	3,100
June	3,800	December	3,200

In any year, when rainfall permits the objectives for monthly flows to be achieved, the average discharge for the year would be 3,425 cfs.

The division of lake water among the three diversion systems preferred by the Sanitary District, would provide approximately a 1:1 dilution of treated sewage effluent with diversion water. This would involve an annual average diversion of 400 cfs for the North Shore Channel-North Branch Chicago River System, into which about 380 cfs of treated sewage discharges from the Northside Treatment Works and 900 cfs for the Chicago River-South Branch Chicago River System. After receiving the 1,330 cfs of Stickney Treatment Works effluent, the Chicago Sanitary and Ship Canal below the Stickney Works would consist of 1,710 cfs of treatment plant effluent and 1,300 cfs of diversion water, or 57% treated sewage. The diversion for the Calumet-Sag System, which receives about 180 cfs of treated effluent, would be 200 cfs. The combined flow in the Chicago Sanitary and Ship Canal below the Calumet-Sag Channel would be 1,890 cfs of effluent and 1,500 cfs of diversion water, or 56% treated sewage.

In practice such division of diversion is not accomplished, principally because of lockage requirements for navigation at Blue Island Controlling Works on the Calumet-Sag Channel. These requirements represent an annual average of 600 cfs, which leaves only 900 cfs for use in the other two systems. As a result, the actual diversion for the Chicago River-South Branch System is only 500 cfs, since the desired 400 cfs is maintained in the North Shore Channel-North Branch System. This provides only 900 cfs of diversion water above the Stickney Works; and the flow of the Chicago Sanitary and Ship Canal between the Stickney Works and the Calumet-Sag Channel is 68% treated sewage.

The foregoing numerical values are based on annual averages. The method of operation of the waterway that the Sanitary District considers desirable in order to take full advantage of any dilution provided by rainfall and runoff, and therefore to conserve diversion of lake water, produces periodic flow conditions that are quite different from those represented by annual average values.

When rainfall occurs, or even when a firm prediction of rainfall is received, diversion of water from the lake may be stopped at Wilmette and Chicago Harbor. The only diversion of lake water that continues under such conditions is that dictated by lockage requirements on the Calumet-Sag. When this condition occurs, control over dilution is lost since the area where dilution enters the watercourse as runoff is governed entirely by the chance distribution of rainfall. The need for control of dilution may be greatest during periods of high runoff since storm water overflows from intercepting sewers may impose maximum pollution loads on the watercourse at such times.

During periods of intense rainfall and high runoff the usual direction of flow in portions of the waterway may be reversed in excess of the hydraulic capacity of the system flow to the lake through any of the three diversion control works.

WATER QUALITY STUDY

A preliminary study of water quality of the Illinois Waterway in and below the Chicago Metropolitan Area, extending from Lake Michigan downstream to just below Dresden Island Dam, was conducted during the period, April 24 through May 21, 1961.

The principal purposes of the investigation were to define selected water quality conditions as they existed during the study period, and to obtain information that would be useful in planning a continuing and more extensive stream investigation.

Methods of Physical, Chemical, and Bacteriological Examination

Sampling Stations. The 39 sampling stations operated routinely during the study of the waterway above Dresden Island Dam are shown in Figure 10 and are described in Table 25.

The station designations consist of two capital letters that serve as abbreviations of the names of stream reaches in which the stations lie. The numbers following the letters are the mileage of the stations above the mouth of the Illinois River at Grafton, Illinois. This system identifies stations so that they can be located positively in the field. It also provides a convenient means of determining distances between sampling stations and other points of interest on the waterway.

A few general principles were followed in selecting sampling stations in the free flowing channels. Stations were established at the three points where lake water enters the waterway to provide data on quality of dilution water. In general, where distances permitted, at least three stations were established in stream reaches in which no important changes in the reaches were known to occur. Stations upstream from major tributary streams and sewage treatment plant discharges were located as close to such discharges as was practical. Both plant discharges and tributary streams were sampled and measured as near to the receiving stream as practical to permit computation of conditions in the main channel immediately below such contributions to the main stream. The first station below any treatment plant discharge or tributary stream was located sufficiently far downstream to assure reasonable opportunity for mixing.

In the three pools, Lockport, Brandon Road, and Dresden Island, it was concluded that the limited number of stations which could be maintained within the reserviors would not yield meaningful results, and stations generally were located at the upper ends of the pools and just below the dams impounding the pools. An exception was the Lockport Pool where the station, just above the Lockport Lock and Dam, used by the Sanitary District also was used in this study. Although practical considerations required some variations, the principles were adhered to reasonably closely.

Following the initial tentative establishment of sampling stations from maps, all stations were investigated in the field before routine sampling was started. The investigations included visual observations to determine the exact points from which samples were to be collected. At some stations it was necessary to make temperature and dissolved oxygen (DO) determinations at several points across the channels and at several depths to determine whether the selected points were representative of the stream cross sections involved.

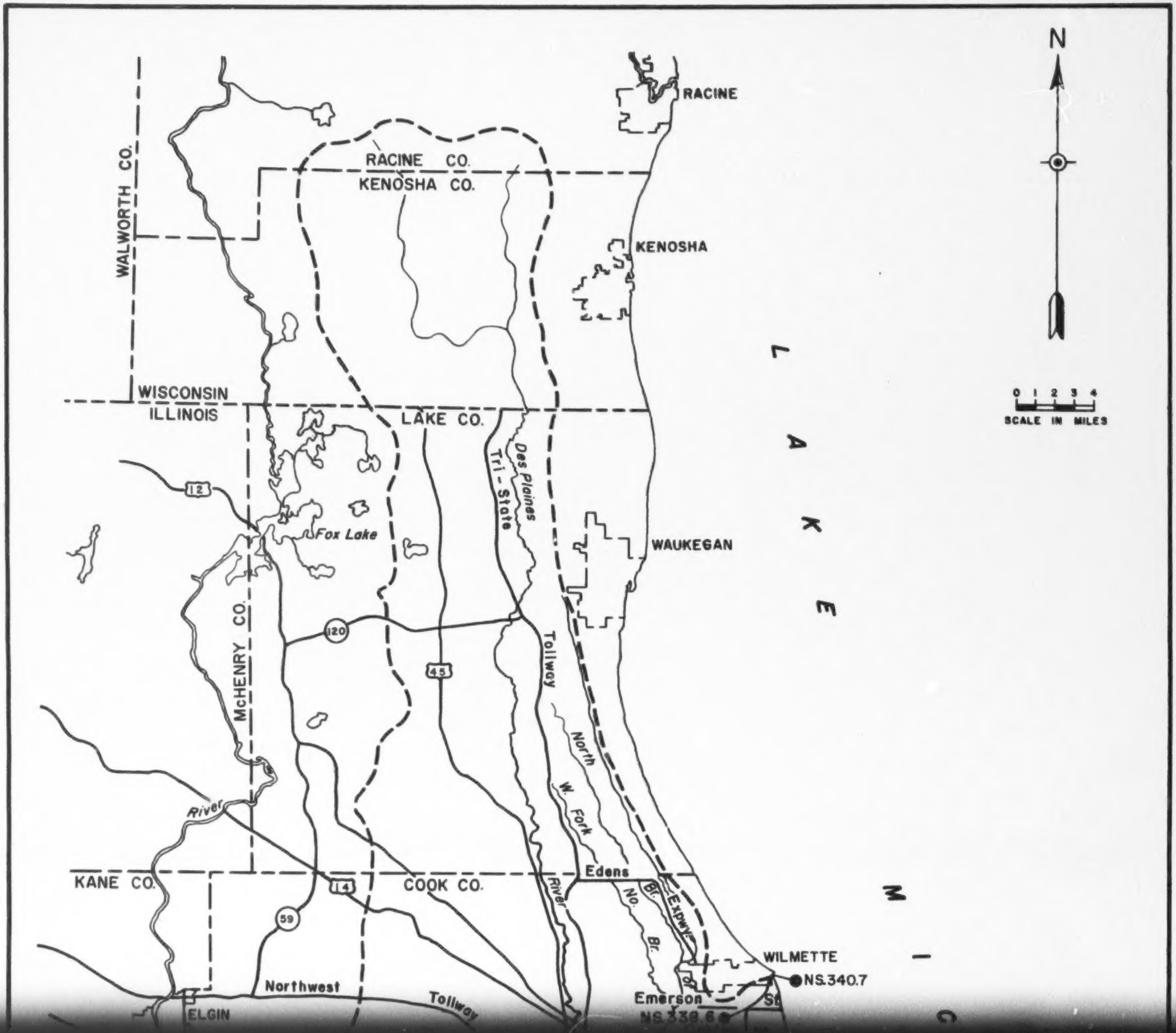
Hydraulic Measurement and Computations

Rather extensive measurements of stream flows were necessary because no regular discharge measurements are made by any agency on the waterway above Lockport. The Sanitary District maintains records of estimated flows at intermediate points, but the data are computed rather than measured.

Hydraulic data required for each day of the sampling period were

1. Average daily flows at each sampling point.
2. Average daily flow of each major tributary.
3. Average daily depth of each reach between sampling stations.
4. Average velocity of flow in each reach.
5. Time of water travel in each reach.

Daily Flows. There are no gaging stations in operation on the main channels used by the Metropolitan Sanitary District for the disposal of treatment plant effluent. Daily flows for the Sanitary and Ship Canal at Lockport are computed by the Sanitary District and published by the United States Geological Survey. Other flow data normally available from the Sanitary District included inflows from Lake Michigan at Wilmette (North Shore Channel), at mouth of Chicago River, and at Blue Island controlling works on Calumet-Sag Channel; discharges from the storm water pumping stations on the Canals; and the discharges from the three major treatment works. During the sampling periods, the Sanitary District furnished, in addition to the data listed above, daily estimates of discharge for North Shore Channel at Foster Avenue; North Branch Chicago River at Kinzie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Fox Lake
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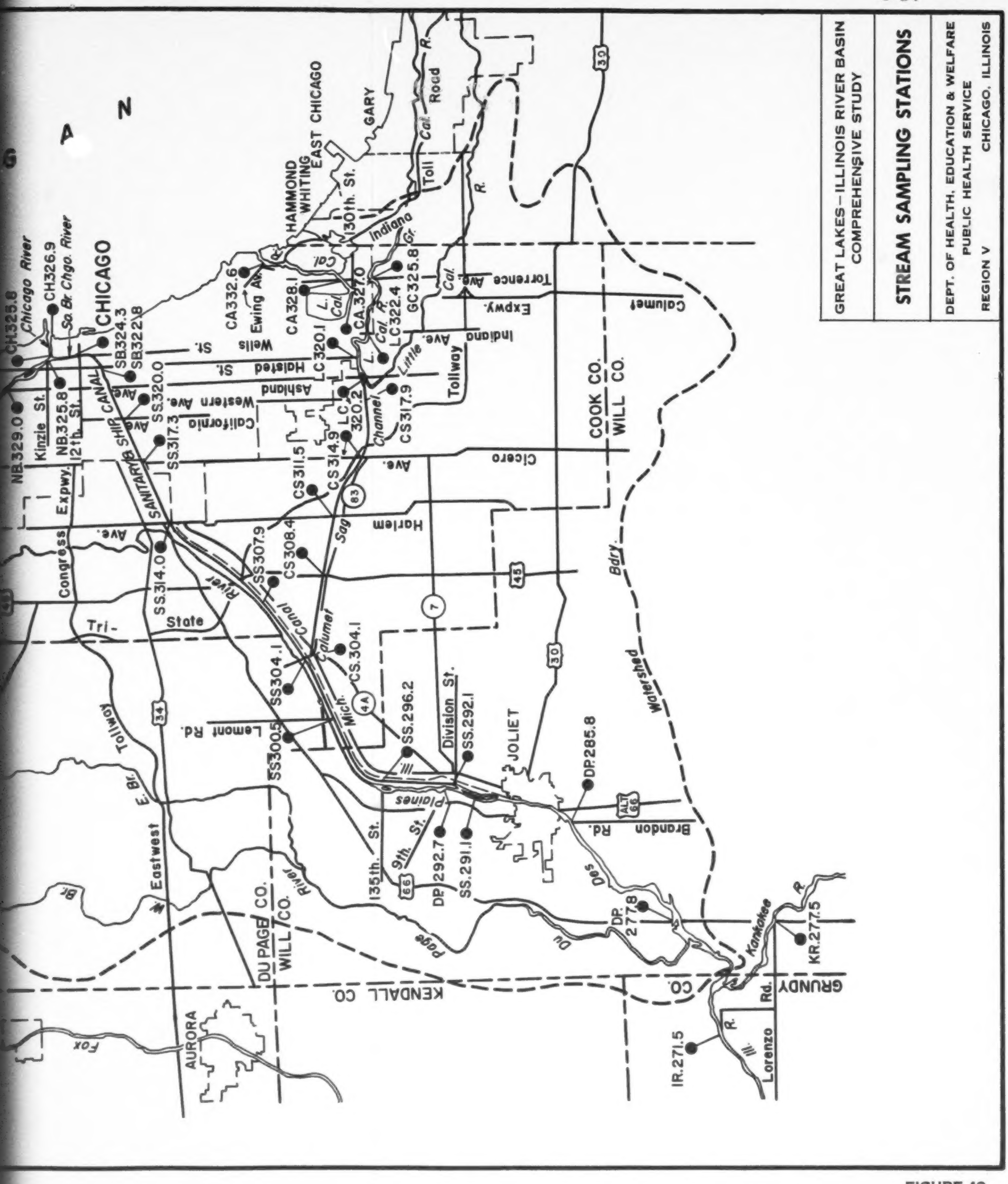
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Chicago River
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SB.324.3
SB.322.8
SS.320.0
SS.317.3
SS.314.0
SS.307.9
SS.304.1
SS.300.5
SS.296.2
SS.292.1
SS.291.1
CS.311.5
CS.314.9
CS.308.4
CS.304.1
CS.317.9
LC.320.2
LC.320.1
LC.322.4
CA.327.0
CA.328.1
CA.332.6
GC.325.8
DP.292.7
DP.285.8
DP.277.8
KR.277.5
IR.271.5
SANITARY & SHIP CANAL
Calumet Sag Channel
Little Cal. R.
L. Cal.
Cal. R.
Gr. Cal.
Mich. Canal
Des Plaines River
Du Page River
Kankakee R.
Ill. R.
Fox
E. Br.
Br.
Kinzie St.
12th. St.
Expwy.
Congress
Ave.
Tri-State
Tollway
Eastwest
Lemont Rd.
135th. St.
9th. St.
Division St.
Brandon Rd.
Lorenzo Rd.
Cicero Ave.
Harlem
California Ave.
Western Ave.
Ashland
Halsted St.
Wells St.
Ewing Av.
Indiana Ave.
Torrence Ave.
Calumet Expwy.
Indiana Toll Road
130th. St.
Cal. R.
Tollway
COOK CO.
WILL CO.
DU PAGE CO.
WILL CO.
KENDALL CO.
GRUNDY CO.
Bdry.
Watershed
45
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ALT 66
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GREAT LAKES—ILLINOIS RIVER BASIN COMPREHENSIVE STUDY

STREAM SAMPLING STATIONS

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION V
CHICAGO, ILLINOIS

FIGURE 10

Street; South Branch Chicago River at Lake Street; Sanitary and Ship Canal at Harlem Avenue and at Lockport; and Calumet-Sag Channel at Blue Island Control Works and at Sag Junction.

In order to obtain measured flows to augment the data furnished by the Sanitary District, a contract was entered into with the United States Geological Survey, Champaign, Illinois for daily discharge measurements during the sampling period at each of the following stations:

North Branch of Chicago River at Montrose Avenue, Chicago, Illinois
Sanitary and Ship Canal at Wentworth Avenue, Willow Springs, Ill.
Calumet-Sag Channel at Harlem Avenue, Ill. Highway No. 4A.

Daily flows of major tributaries were determined from once daily gage readings obtained by sampling crews at the following United States Geological Survey gaging stations:

North Branch Chicago River at Touhy Avenue, Niles, Ill.
Little Calumet River at South Holland, Ill.
Tinley Creek near Palos Park, Ill.
Midlothian Creek at Oak Forest, Ill.
Des Plaines River at Riverside, Ill.
Flagg Creek near Willow Springs, Ill.
Hickory Creek at Joliet, Ill.
Du Page River at Troy, Ill.
Kankakee River near Wilmington, Ill.

Daily flows at the sampling points were based on routings of the daily flows for the locations listed above.

Although some rainfall occurred on several days during the sampling period, only one period of runoff appreciably affected flows in the Canal system. This runoff period occurred during the early part of the study, April 24-25, when daily discharge at Lockport rose from 3,900 to 6,500 cubic feet per second. Minor runoff on tributary streams occurred May 8-9, and again May 14-15.

Average Water Depths. All available cross sections for the reaches between sampling points were assembled from the Chicago District, Corps of Engineers, and from the Metropolitan Sanitary District. Average cross sectional areas, top widths and water depths were determined for each reach for a control water elevation. From these data the average depth for each reach for the water elevation occurring on each day was determined from gage heights supplied by the Metropolitan Sanitary District.

Times of Water Travel. Several of the reactions involved in natural purification of streams are functions of time. Full understanding and interpretation of stream data are possible only if the times required for the water to pass between pertinent points are known. Average discharges for each reach were computed from the discharges at sampling points. Average velocity for each reach was then computed from average discharge and average cross-sectional area. Time of water travel was then obtained by dividing length of reach by average velocity.

Sample Collection

With minor exceptions, samples were collected daily at all sampling points for 13 days from April 24 through May 6, 1961, and again for 13 days from May 9 through 21, 1961. The minor exceptions resulted from the need to make certain adjustments in sampling stations when the initial data obtained indicated the need for such adjustments.

Sample collection at individual stations was varied throughout the daylight hours as much as was feasible. This was accomplished by starting at alternate days, and by staggering the times of starting the sampling runs.

Collection of samples was from bridges except in the downtown area, where samples were collected by boat. Boat sampling included seven stations on the Main Channel, from NB 331.4 through SS 317.3, and the two stations on the Chicago River.

Samples were collected generally at the middle of the main current of the stream at each station, and at the approximate mid-depth of the water, with the exception of samples for coliform bacteria determinations. The latter were collected within a few inches of the water surface.

Dissolved oxygen samples were collected in modified Ohio River type samplers, which prevent aeration of the samples. The excess water in the samplers was used for determination of temperature immediately after collection, and was iced for subsequent determination of pH and biochemical oxygen demand (BOD).

TABLE 25
SAMPLING STATIONS

Stream (1)	Station River Miles (2)	Location (3)	Remarks (4)
North Shore Channel	NS 340.7[a]	Sheridan Rd.	Control works to admit lake water to waterway.
	NS 338.6	Emerson St.	
	NS 336.9	Oakton Street	Above North Side Treatment Works.
	NS 334.9[a]	W. Devon St.	Below North Side Treatment Works.
	NS 333.4	W. Foster St.	Above confluence with North Branch Chicago River.
North Branch Chicago River	NB 333.4	Albany Ave. Footbridge	Above confluence with North Shore Channel.
	NB 331.4[a]	W. Addison St.	Below confluence with North Shore Channel.
	NB 329.0	No. Ashland Ave.	
	NB 325.8	W. Kinzie St.	Above confluence with Chicago River.
Chicago River	CH 326.9[a]	Lake Shore Drive	At Chicago Harbor where lake water enters waterway.
	CH 325.8[a]	No. Wells St.	Above confluence with North Branch Chicago River.
South Branch Chicago River	SB 324.3[a]	W. Roosevelt Rd.	Below confluence with North Branch Chicago River and Chicago River.
	SB 322.8	So. Halsted St.	
Chicago Sanitary and Ship Canal	SS 320.0[a]	So. California Ave.	
	SS 317.3[a]	So. Cicero Ave.	Above Stickney Treatment Works.
Chicago Sanitary and Ship Canal (continued)	SS 314.0[a]	So. Harlem Ave.	Below Stickney Treatment Works.
	SS 307.9[a]	Wentworth Ave.	
	SS 304.1	Ill. Highway No. 83	
	SS 300.5[a]	Stephen St.	Above confluence with Calumet - Sag Channel.
	SS 296.2	135th St.	
	SS 292.1	Division St.	In Lockport Pool
	SS 291.1[a]	Lockport Dam	Just above Lockport Dam and above confluence with Des Plaines River Sanitary District control point.

Des Plaines River	DP 292.7(a)	Ill. Highway No. 7	Above confluence with Chicago Sanitary and Ship Canal.
	DP 285.8(a)	Brandon Rd.	Below confluence with Chicago Sanitary and Ship Canal and below Brandon Dam (Biological samples in Brandon Pool).
	DP 277.8	U.S. Highway No. 66	Midway Dresden Island Pool and above confluence with Kankakee River.
Kankakee River	KR 277.5(a)	U.S. Highway No. 66	Above confluence with Des Plaines River (Biological samples 1/4 mile upstream from Will Co. Line Bridge).
Illinois River	IR 271.5(a)	Dresden Island Dam	Just below Dresden Island Dam, and below confluence of Des Plaines and Kankakee Rivers. (Biological samples in Dresden Pool).
Calumet River	CA 332.6(a)	So. Ewing Ave.	About 0.8 mile downstream from Calumet Harbor, where lake water enters waterway.
	CA 328.1(a)	So. Torrence Ave.	Above connection with Calumet Lake.
	CA 327.0	130th Street	Below connection with Calumet Lake, and above confluence with Grand Calumet River.
Grand Calumet River	GC 325.8(a)	So. Torrence Ave.	Above confluence with Little Calumet River.
Little Calumet River	LC 322.4(a)	So. Indiana Ave.	Below confluence of Calumet and Grand Calumet Rivers.
	LC 320.1(a)	So. Halsted St.	Above Calumet Treatment Works and confluence with Cal-Sag Channel.
	LC 320.2(a)	Ashland Ave.	Above confluence of Little Calumet River and Cal-Sag Channel.
Calumet-Sag Channel	CS 317.9(a)	So. Western Ave.	Below confluence of Little Calumet River and Cal-Sag Channel and Calumet Treatment Works.
	CS 314.9	So. Cicero Ave.	
	CS 311.5	So. Harlem Ave.	
	CS 308.4	U. S. Highway No. 45	
	CS 304.1	Ill. Highway No. 83	Above confluence with Chicago Sanitary and Ship Canal.

(a) Bottom Organisms Stations

Samples for coliform bacteria were collected in sterilized bottles. The open bottles were lowered into the water in weighted frame samplers.

Samples for DO, BOD, pH and coliform organisms were iced in closed ice chests for transportation to the laboratory.

Generally, samples were delivered to the laboratory within 3 to 3.5 hours after the time of collection of the first sample on any sampling run, and analyses of samples were started within 4 hours of the start of sampling.

Laboratory Procedures

Analytical determinations were made at the laboratory of the Great Lakes-Illinois River Basins Comprehensive Study Project at 5555 South Archer Avenue. Chemical and bacteriological examinations were under the supervision of experienced sanitary water chemists and bacteriologists. Analytical procedures followed the recommendations of *Standard Methods for the Examination of Water and Wastewater*. Determinations were made routinely on samples for pH, coliform bacteria, DO and five-day 20° C BOD. The coliform bacteria examinations were performed by the membrane filter (MF) technique.

Data Processing

Computations of final laboratory results generally were completed by the end of the day on which analyses were completed. At the end of each day the data were tabulated for review. Within two or three days after completion of analytical results the data were put on punch cards and at weekly intervals all data were printed out by machine and averaged to permit further review. This procedure permitted early examination of the data to detect need for revisions in sampling stations and procedures, and to determine special investigations that might be indicated to explain apparently abnormal results. Tabulations of daily data and of final average, maximum, and minimum values were completed within two days after final data were produced by the laboratory.

Special Investigations

A number of special investigations were made to assure the adequacy of sampling stations, sampling procedures, and analytical results, and to assist in the ultimate interpretation of data.

Stratification. The entrance of cool lake water into the warmer water of the waterway led to the belief that the cooler lake water might flow along the bottom of the system for significant distances before mixing. It also was believed that there might be thermal stratification below points of discharge of cooling water from steam power plants, and in the Lockport, Brandon Road, or Dresden Island pools.

Before routine sampling started, determination of temperatures at various depths at selected stations throughout the waterway indicated that significant thermal stratification did not occur at that time.

As data were accumulated during the regular study it appeared that there were puzzling irregularities in the data from the Brandon Road Station (DP 285.8) downstream through the Dresden Island Station (IR 271.5).

Additional investigation indicated that the Brandon Road Station (DP 285.8) was not a satisfactory sampling location. The sampling point was located approximately in the middle of the rapids which extended about 0.8 miles downstream from the Brandon Road Dam spillway and did not include water discharge through the locks. In addition, luxuriant growths of filamentous algae were attached to the channel of the rapids. The Brandon Road Station should be replaced by two stations, one above the dam and one below the point where the spillway rapids join the navigation channel. These stations should be sampled around the clock to obtain an accurate measurement of the actual quantity of oxygen added by this valuable source of dissolved oxygen.

A second investigation of stratification in the Dresden Island Pool near the end of the study indicated that stratification had developed since the earlier investigation. The cooler water of the Kankakee River apparently was flowing along the bottom of the Dresden Island Pool, underneath the warmer water originating upstream of the confluence of the Kankakee and Des Plaines Rivers. This stratification apparently persisted for the 1.3 miles between the confluence of the two rivers and the Dresden Island Dam. The mixture of the two waters in passing through the dam could vary rather widely from time to time, depending on relative discharges and temperatures of the two Rivers, and on methods of operating the spillway and the lock. This could lead to wide variations in the results on samples collected at the station below the Dresden Island Dam. (IR 271.5).

Further investigation of the stratification and of its effect on sample results at the station below the dam may indicate a need for relocation of this station.

Dissolved Oxygen Variability. In many surface waters photosynthetic production of oxygen by algae leads to considerable variation in DO, between daylight, when DO is high, and dark, when DO is low. An investigation extending over four nights was undertaken to determine whether DO results on samples collected during daylight only would be representative of around-the-clock DO levels.

Nighttime DO determinations were made at all stations except the one below Dresden Island Dam, where access during the night was not possible. Comparison of the DO results obtained during the night at each station with the results at the same station during daylight on the day preceding and the day following the night sampling indicated that variability in DO because of photosynthesis was not significant during the study.

The effectiveness of ice preservation of samples for subsequent determination of DO was investigated. At each station a DO determination was made on one sample immediately after collection, and a duplicate sample was iced and delivered to the laboratory for a check DO determination. No significant differences in DO were obtained by the two procedures.

Lake Water Quality. As early analytical results became available it soon was obvious that the stations established at the three points of lake water diversion were not representative of unpolluted water.

At the Wilmette Control Works (NS 340.7) although the DO was quite high, generally being supersaturated, the BOD was unexpectedly high, with many values in the range of 5 to 10 mg/l. Since the coliform bacteria were low, except during periods of rainfall and runoff, it did not appear that sewage caused the high BOD. In fact, no source of either sewage or industrial waste could be found in the vicinity of the Wilmette Control Works.

At Chicago Harbor (CH 326.9) the DO was very near saturation but the BOD, while lower than at Wilmette, still was higher than was expected, with many values near 4 mg/l. Coliform bacteria were somewhat higher than at Wilmette, but still were not excessive during dry weather.

At Calumet Harbor (CA 332.6) the DO frequently was quite low, with several values below 5 mg/l. The BOD was near the same levels as those at Chicago Harbor. The coliform bacteria results were erratic, with some values comparable to those at Chicago Harbor, but with a number of high values that could not be accounted for by rainfall and runoff. It was realized that this was not a desirable location when it was selected initially, but it was the only station near the harbor accessible by car. Although there are two steel plants along the Calumet River between the sampling station and the harbor, one of them was closed down and representatives of the other stated that no wastes were discharged from the plant to the Calumet River.

Although the results at the first two of the three diversion points represented the quality of water as it entered the waterway from the lake during the study, it was obvious that they were not representative of unpolluted lake water. A number of samples collected farther out in the lake confirmed this conclusion. These samples yielded results indicating that the DO of unpolluted lake water was near saturation, the BOD was about 2 mg/l., and coliform bacteria were probably less than 100 per 100 ml.

More investigation is needed to establish the true quality of lake water entering the waterway for dilution purposes. The Calumet Harbor Station results definitely are not representative of lake water quality; rather they appear to reflect the effects of pollution from industrial plants along the shore discharging into the harbor area. There also is the possiblity that variations in lake level may induce reversals of flow at this station, and that some of the results may be measures of pollution discharged by plants downstream from the sampling station and brought upstream to the sampling point by flow reversals. The Wilmette and Chicago Harbor Stations may be satisfactory if the increase in BOD from outside the harbors to the sampling points can be explained.

Biochemical Oxygen Demand. Knowledge of the rates at which BOD is exerted in the watercourse is essential for reliable calculations of BOD exertion, DO utilization and reaeration, waste reduction and dilution water needs. No information on this important factor, based on actual laboratory determinations, was found in preliminary investigations of available sources of data.

During this study, about 20 samples were collected from selected stations and long term BOD's, at frequent intervals up to 30 days, were run to establish the deoxygenation coefficients necessary for reliable computation of rates of BOD exertion.

A factor in the computation of the effects of sludge deposits is the portion of the total BOD carried by a stream which will settle to the bottom to form sludge deposits. No previous information on this factor for the waterway was found in preliminary investigation of available data.

Twelve special samples were collected from the lower end of the waterway from just above the Stickney Works downstream to Dresden Island Dam, including two samples from the lower end of the Calumet-Sag Channel. Two and five-day BOD's were determined on the samples as collected, and also on the supernatant of two-liter portions of the samples which had been settled for two hours. By difference between the two sets of BOD values, it is possible to calculate the portion of the BOD that could settle to form sludge deposits.

The procedure for determing BOD is such that dilution of the sample is necessary to obtain a finite result if the five-day BOD of the sample exceeds about seven mg/l. In spite of use of the procedure for many years, there still remains some question regarding the effects of dilution on the BOD results obtained. In those reaches of the waterway where the BOD was expected to be less than seven mg/l. the BOD's were determined without dilution. In addition, all samples were diluted with standard, seeded dilution water to permit a comparison, where possible, between diluted and undiluted sample results.

Coliform Bacteria. Previous data on bacterial contamination of the watercourse above Lockport Dam was not found during review of available information.

The new edition of *Standard Methods for Examination of Water and Wastewater*, published in 1960, recognizes, for the first time, the membrane filter procedure as a standard method for determination of coliform bacteria. This method was used routinely on all samples. In addition, duplicates of one out of every six samples were checked by the multiple dilution procedure, which has been the standard method for determination of coliform bacteria for many years. The duplicate results permit comparison of the data obtained by the two standard procedures.

PRESENTATION OF DATA

Average results of analytical determinations during the period of study are presented in Table 26. The data of specific determinations are plotted as follows:

Figure 11 - Temperature

Figure 12 - pH

Figure 13 - BOD

Figure 14 - Dissolved Oxygen

Figure 15 - Coliform Organisms,Main Channel

Figure 16 - Coliform Organisms, Calumet-Sag and Chicago River

The data presented is limited to averages obtained during the study, with no separation at this time of the results by selected temperature ranges, wet versus dry weather conditions, or other factors which tend to exert variable influences on the reactions of pollution in the waterway. For example, rather heavy rainfall and runoff occurred during the first three days of the study. The effects of the surface runoff are reflected by the data at many stations, being especially evident in the results for coliform bacteria at those stations where bacterial contamination normally was low.

At this time detailed analysis and interpretation of data has not been completed. The subsequent presentation deals primarily with discussion of water conditions that existed in the Illinois Waterway during April 24 through May 21, 1961, with comments suggested by a combination of knowledge of those conditions and of various characteristics of the system.

A detailed analysis and interpretation of the data will be undertaken and such projections as the data permit will be made in a supplemental report. It already is obvious, however, that much additional field study will be necessary before full projection of data can be made to define the probable effects on water quality of changes in waste loads and in diversion of lake water for dilution of wastes from the Chicago Metropolitan Area.

Although the work on this problem cannot be considered completed, it should be emphasized that the work already accomplished provides more systematic and detailed information on water quality in the waterway above Lockport than previously has been available from any source. Sound evaluation of the probable impact of changes in waste loads and in quantities of dilution water diverted from the lake must be based on a thorough knowledge of quantitative reactions of pollution and of natural pollution in the waterway from the points of waste discharge to the point of essential recovery from the effects of pollution. Such understanding can be achieved only through careful, imaginative analysis and interpretation of sound detailed scientific data, systematically procured. No such body of data on the waterway from Lake Michigan to the point of virtual recovery at Dresden Island Dam has been found in reviewing information previously available.

A start towards the accumulation of the necessary data has been made during the April 24 through May 21, 1961 period. This undertaking will be continued until data adequate for the necessary evaluation are available. Although limited tentative conclusions may be drawn from the present data, any attempt to arrive at final conclusions regarding the effects of changes in waste loads or dilution water based on data now available would be only little more than an academic exercise in mathematics.

Physical Appearance

The Illinois Waterway from the Wilmette inlet to the Illinois River is subjected to observation by a large number of people. In its course the waterway travels through numerous towns and cities, including the heart of the Chicago business district. Included along its course are many desirable neighborhoods with homes, children's playgrounds, and other recreational facilities.

The physical appearances of a stream are of utmost importance when considering pollutional conditions. They are the conditions that can be observed and understood. Modern scientific methods frequently tend to minimize the importance of visible evidence. However, visible evidence is most easily understood, particularly by those not familar with scientific terms used to express pollutional quantities.

A variety of materials was observed along the banks and on the surface of the waterway during the period March 22 through May 21, 1961. Some of the items observed on the water surface were: innumerable condoms; feces; paper; detergent foam; rubbish; tires; furniture; logs; timber (or used lumber) of various description; tree branches and trimmings; bottles; cans of sizes from small food containers to oil drums; rising gas bubbles giving the appearance of rain falling on the river ; dead fish; material that appeared to be ground garbage; and in one area, sludge rising in such a manner that the water appeared to boil.

Items observed along the banks included trash and rubbish dumps; rats; outfalls of various sizes and descriptions (some discharging and some not).

Various uses were observed on and near the waterway including: pleasure boat docking facilities; barge and ship loading and unloading; industrial plants; and many other operations. On several occasions, children were seen playing along the banks and in one instance they were observed swimming.

Dredging and widening operations were in progress along the Calumet-Sag Channel during the study period April 24 through May 21, 1961.

The amount of debris and other material floating on the surface varied from time to time. When water was not entering the North Shore Channel from the lake, the abundance of floating materials was considerably greater in that part of the system. This was also observed at and below the Chicago River area.

TABLE 26
LABORATORY AND FLOW DATA
RESULTS OF ANALYSIS
MEAN VALUES - APRIL 24 - MAY 21, 1961

Sampling Station (1)	Temp. °C (2)	DO mg/1 (3)	BOD 5-day 20° C mg/1 (4)	Coliforms per 100 ml (5)	pH (6)	Flow cfs (7)
STICKNEY TREATMENT WORKS (315.8)						1310
SS 314.0	18.8	4.4	11.1	410,000	7.3	3210
SS 307.9	18.5	1.9	10.3	490,000	7.3	3291
SS 304.1	18.0	1.1	8.5	520,000	7.3	3291
CALUMET SYSTEM(a) (303.4)						754
SS 300.5	17.6	1.1	6.9	290,000	7.3	3977
SS 296.2	17.1	0.7	6.2	440,000	7.4	3914
SS 292.1	18.5	0.6	6.1	180,000	7.3	3850
SS 291.1	17.9	0.8	5.5	166,000	7.3	3774
DES PLAINES RIVER(a) (290.0)						691
DP 285.8	18.1	7.5	7.5	117,000	7.5	4697
DP 277.8	18.2	5.4	7.3	39,000	7.5	4715
KANKAKEE RIVER(a) (272.8)						9157
IR 271.5	15.9	8.8	4.3	16,000	7.8	14068
MAIN STEM						
NS 340.7	11.5	12.1	5.7	730	8.5	761
NS 338.6	11.3	12.1	5.6	18,200	8.5	763
NS 336.9	11.3	11.5	6.0	49,000	8.5	765
NORTHSIDE TREATMENT WORKS (336.6)						356
NS 334.9	12.5	9.8	8.9	200,000	7.8	1140
NS 333.4	12.7	9.6	7.4	180,000	7.7	1144
NORTH BRANCH(a) (333.0)						101
NB 331.4	11.9	8.0	6.6	270,000	7.6	1249
NB 329.0	12.3	6.2	8.5	390,000	7.5	1257
NB 325.8	12.5	5.0	7.2	580,000	7.7	1267
CHICAGO RIVER(a) (325.6)						490
SB 324.3	12.0	6.5	5.5	400,000	7.7	1774
SB 322.8	12.1	5.7	5.4	440,000	7.6	1801
SS 320.0	13.9	5.4	5.6	520,000	7.6	1854
SS 317.3	16.6	4.5	5.8	870,000	7.6	1897

TABLE 26 (Continued)

Sampling Station (1)	Temp. °C (2)	DO mg/1 (3)	BOD 5-day 20° C mg/1 (4)	Coliforms per 100 ml (5)	pH (6)	Flow cfs (7)
TRIBUTARIES						
NORTH BRANCH(a) (333.0)						
NB 333.4	14.5	9.6	11.0	100,000	8.1	101
CHICAGO RIVER(a) (325.6)						
CH 326.9	10.6	10.8	3.4	22,000	8.3	488
CH 325.8	11.0	9.9	3.6	37,000	8.3	490
CALUMET SYSTEM(a) (303.4)						
CA 332.6	13.0	7.2	3.8	8,400	7.7	341
CA 328.1	16.6	3.2	5.2	40,000	7.5	344
CA 327.0	16.3	4.4	4.8	30,000	7.6	344
GRAND CALUMET RIVER(b) (325.7)						7
LC 322.4	14.4	3.7	5.9	85,000	7.5	348
LC 320.1	14.3	4.2	5.6	72,000	7.4	489
LITTLE CALUMET RIVER(b) (319.5)						409
CALUMET TREATMENT WORKS (319.2)						212
CS 317.9	14.2	3.6	6.9	130,000	7.4	660
CS 314.9	14.9	3.3	7.6	160,000	7.4	701
CS 311.5	14.9	2.7	6.5	120,000	7.4	729
CS 308.4	14.8	2.6	6.2	120,000	7.4	740
CS 304.1	15.7	2.8	6.4	45,000	7.4	754
GRAND CALUMET RIVER(b) (325.7)						
GC 325.8	14.8	0.5	28.9	2,943,000	7.4	7
LITTLE CALUMET RIVER(b) (319.5)						
LC 320.2	14.0	4.9	8.4	160,000	7.6	409
DES PLAINES RIVER(a) (290.0)						
DP 292.7	15.3	9.9	5.7	7,700	8.1	691
KANKAKEE RIVER(a) (272.8)						
KR 277.5	14.9	9.0	3.0	54,000	7.9	9157

(a) Tributary to Main Stem
(b) Subtributaries - (to Calumet System)

On one occasion (May 20) floating debris was observed in unusually heavy quantities from the Chicago Harbor area to the Dresden Dam Pool. Debris, particularly floating logs and other wood materials, in this stretch was such that travel by small boats was hazardous.

In the area from the North Branch-Chicago River confluence to a point above the Stickney Works the water was grey to dark, with an odor typical of oil and grease. Below the Stickney Works the water was light brown with an odor typical of activated sludge.

A fine floc was present in most of the samples collected along the waterway, and in some cases septic odors were noticed. Along the waterway, septic odors were present in the sludge lagoon area below the Stickney Works.

Physical appearance of a large part of the waterway during the period of observation was extremely objectionable.

Temperature

The temperature (Figure 11) of the lake water entering the waterway at Wilmette and Chicago Harbor averaged about 11°C during the study, being a little higher at Wilmette than at Chicago Harbor. The average temperature of 13°C for Calumet Harbor probably did not represent the actual temperature of lake water, but reflected the temperature of the lake water soon after entering the Calumet-Sag System.

In the North Shore Channel there was no significant change in temperature until the water passed the Northside Treatment Works. Here the warmer sewage effluent increased the temperature by a little over 1°C. From just below the sewage treatment plant on down the North Shore Channel, the North Branch Chicago River and the South Branch Chicago River to Station SB 322.8, there were only minor fluctuations in temperature, in the range of 11.9 to 12.7°C.

Between Stations SB 322.8 and SS 314.0, a distance of 8.8 miles, three Commonwealth Edison Company steam power plants discharge cooling water. The effect of these discharges was reflected in a temperature increase of 6.7°C. Although the Stickney Works discharged into the reach between SS 317.3 and SS 314.0, it did not contribute to the increase in temperature. The temperature of the effluent averaged essentially the same as that of the river upstream at SS 317.3.

From the station below the Stickney Works on down to the Dresden Pool (DP 277.8) only minor fluctuations in temperature, in the range of 17.1 to 18.8°C, were indicated by the temperature averaged. Several factors probably were involved in these fluctuations, including three additional Commonwealth Edison plant discharges and possibly discharges from other industrial plants, and cooler water from the Calumet-Sag Channel and Des Plaines River, as well as other smaller tributary streams.

The average temperature of the Calumet system near the lake (CA 332.6) was 13.° C, which was probably slightly higher than actual lake water temperature, as has been noted earlier. The data indicated an increase to 16.6°C at CA 328.1, followed by a slight drop to 16.3°C at CA 327.0 and a sharper decrease to 14.4° C at LC 322.4. While the indicated increase of more than 3°C does not appear unreasonable, in view of the concentration of industrial water uses along this reach of the stream, the sharp drop to LC 322.4 does not appear logical. Review of the sampling records indicates that the general principle of sampling at mid-depths was not followed at Stations CA 328.1 and CA 327.0. At CA 328.1, where the depth was about 25 feet, the samples were collected 5 feet below the surface. At CA 327.0, where abrupt change in depth from about 20 to 10 feet occurs, the samples were collected 3 feet below the surface. It is possible that there was stratification at these two stations, and that cooler water from the lake was flowing underneath the surface water which had been warmed by industrial use. In the shallower channel below CA 327.0 there probably was vertical mixing, and the average temperature of 14.4°C at LC 322.4, representing an increase of only 1.4°C from CA 332.6, probably is a better indication of the actual increase in temperature attributable to industrial cooling water uses in this stream reach.

From LC 322.4 to CS 304.1, just above the confluence of the Calumet-Sag Channel and the Chicago Sanitary and Ship Canal, the average temperature fluctuated between 14.2 and 15.7° C. Much of this 1.5°C range was the result of an increase of 0.9°C between CS 308.4 and CS 304.1, the two farthest downstream stations on the Calumet-Sag Channel. There is no apparent explanation for this increase, since there is no presently known source of heat

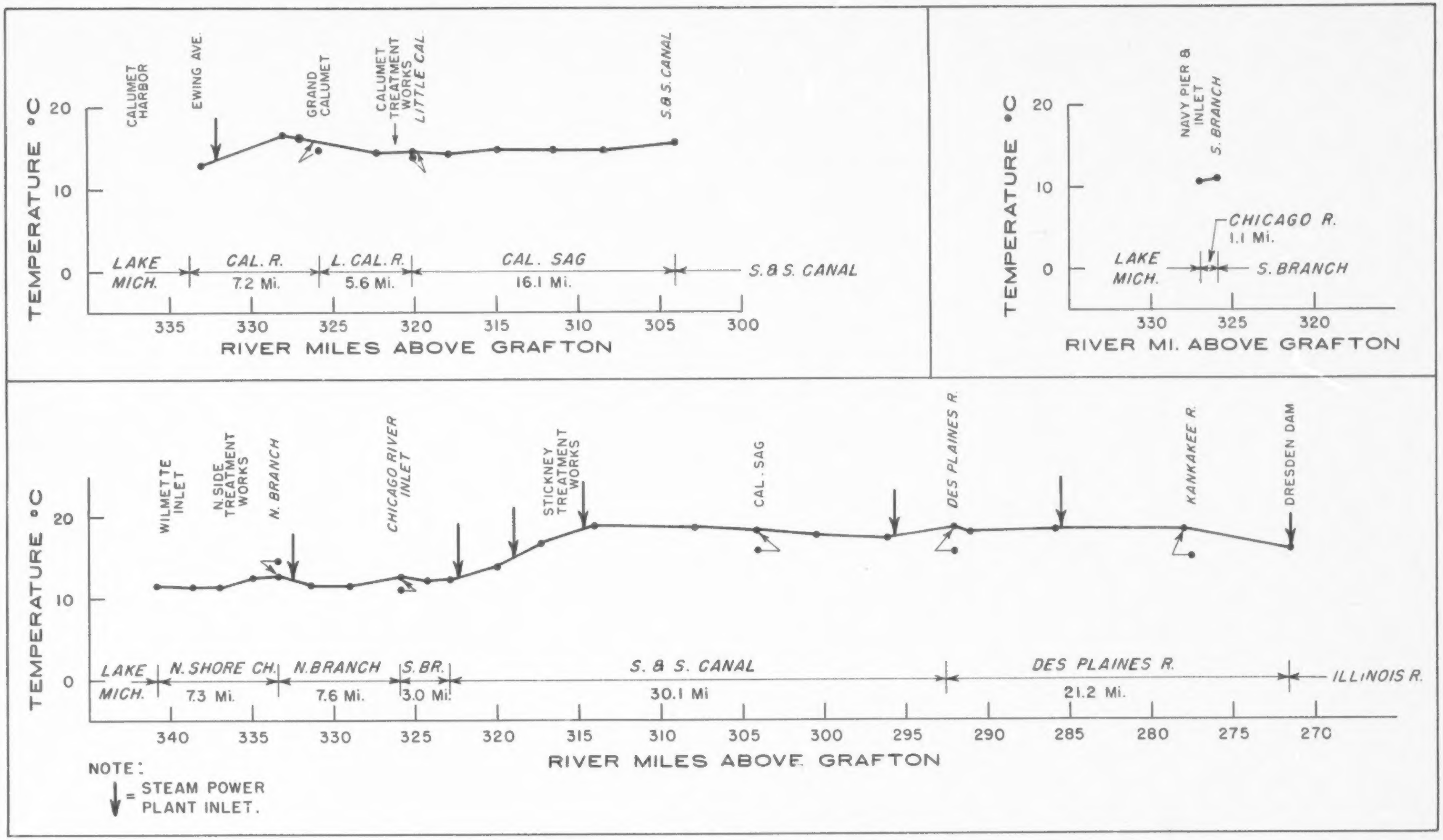


FIGURE 11

TEMPERATURE AVERAGES
LAKE MICHIGAN - ILLINOIS RIVER BASINS
COMPREHENSIVE STUDY
APRIL 24 THRU. MAY 21, 1961

62-a

along this reach of the channel.

The most significant change in temperature that occurred in the waterway was the 6.7°C increase near the upper end of the Chicago Sanitary and Ship Canal that apparently was caused by the three Commonwealth Edison Steam Power Plants. The net change throughout the main channel from the lake to the farthest downstream station above the Kankakee River was about 7.1°C.

Increased temperature of water may have several adverse effects. The higher the temperature of water, the more rapid will be the rate of exertion of oxygen demand. At the same time, the dissolved oxygen saturation value is decreased by higher temperature. Temperature in excess of natural water temperature may kill fish and adversely affect other aquatic life. High temperatures reduce the effectiveness of water used for cooling in steam power and other industrial plants.

pH

The data on pH did not indicate any significant effect of pollution on the hydrogen ion concentration, or alkalinity-acidity balance, of the water (Figure 12). The average pH of the lake water was between 8.3 at Chicago Harbor (CH 326.9) and 8.5 at the Wilmette Control Works (NS 340.7). These results are near the upper end of the range of alkaline values found in most natural surface waters. The average pH of the station on the Calumet River near Calumet Harbor (CA 332.6) was only 7.7. The difference between this value and those for the other two lake stations confirms the evidence of the temperature data that the Calumet River Station was not representative of unpolluted lake water.

The treated sewage effluent from the Northside Treatment Works reduced the pH from 8.5 at Station NS 336.9 to 7.8 at NS 334.9. Only small changes in pH occurred from this station downstream to SS 317.3, where the average was 7.6. The Stickney Treatment Works effluent reduced the pH to 7.3 at Station SS 314.0. There was no further reduction below this point, and the pH rose gradually in the lower end of the waterway to 7.8 at IR 271.5.

There was no important change in pH from the upper to the lower end of the Calumet system, which showed only a small reduction from 7.7 at CA 332.6 to 7.4 at CS 304.1.

The reductions in pH were normal for a stream carrying quantities of decomposable organic wastes. Excess carbon dioxide produced by the process of decomposition depresses the pH of the water. As the stream recovers from the effects of organic pollution and the rate of decomposition is reduced, the excess carbon dioxide escapes to the atmosphere and the pH of the water rises.

At no station was the pH of the water depressed below the neutral point into the acid range. There was no evidence that adverse pH conditions existed in the waterway.

BOD

The standard laboratory BOD determination measures the DO used in 5 days at 20°C. While considerable information can be obtained from consideration of the 5-day BOD's only at successive stations on a polluted stream, the 5-day value must be supplemented by other data if the maximum information is to be obtained from the results of this parameter. The supplemental data are particularly important if sound projections are to be made in estimating the water quality effects that will occur under conditions of waste load and stream flows other than those that existed during the period of field study.

The most important supplemental data can be obtained by determination of BOD of an individual sample at frequent intervals over an extended period of time. The results of this determination, commonly called long-term BOD, are necessary for measurement of both the rate at which BOD is exerted in the stream, and of the total BOD that can be exerted by the organic pollution. In the absence of such laboratory measurement it is common practice to use engineering judgment in the selection of a BOD rate coefficient and to use this coefficient in computing the total BOD from the 5-day value. This practice can lead to serious error in calculating the effects of change in waste loads and stream flow on water quality.

No known results of long-term BOD measurement on the waterway in the Chicago Metropolitan Area were available before the April 24 through May 21, 1961 study. Such determinations, extending over 30-day periods, were made on samples from a number of selected stations during the study. Since it was not possible to start some of the long-term BOD's until the latter part of the study, these results have not yet been completed by the laboratory. For this reason, discussion of BOD at this time is limited to the 5-day values. The unexpectedly high BOD values found on lake water at or near the three points of entry of the water to the waterway have been discussed under the section on "Special Studies." At the Wilmette Control Works (NS 340.7) the average BOD was 5.7mg/l, at Chicago Harbor (CH 326.9) 3.4 mg/l, and near Calumet Harbor (CA 332.6) 3.8 mg/l. (Figure 13). Samples from several points farther out in the lake indicated that the BOD of unpolluted lake water near the Chicago waterfront averaged about 2mg/l. Further investigation will be necessary to establish the reason for the increase in BOD as the lake water enters the waterway, but the results obtained at the three entry points must be accepted as reliable measurements of the lake water as it enters the system.

In the North Shore Channel the average 5-day BOD dropped very slightly after entering the waterway, from 5.7 mg/l at NS 340.7 to 5.6 mg/l at the next station, NS 338.6. Between this station and the one just above the Northside Treatment Works (NS 336.9), the average BOD rose to 6.0 mg/l. This indicated that one or more unknown waste sources discharged to this reach of the channel. The increase was equivalent to a sewered population, or PE, of about 10,000 persons.

Below the Northside Works the BOD increased to 8.9 mg/l at NS 334.9. This increase represented a PE of about 180,000. The increase was not a great deal more than the PE of the lake water entering at Wilmette, which was about 140,000.

From the first station below the Northside Works the BOD exhibited a reduction downstream to 6.6 mg/l at NB 331.4, but at the next station, NB 329.0, the BOD increased 1.9 mg/l, indicating the entrance of wastes having a PE of nearly 80,000.

Below NB 329.0 the BOD decreased downstream to 5.4 at SB 322.8, but from this station downstream to SS 317.3, above the Stickney Works, the BOD showed little change, increasing 0.4 mg/l. Since continued reduction of BOD should occur in the absence of waste discharges, it appears that wastes with BOD exerted at a rate slightly greater than the BOD reduction by natural purification were dicharged in this reach. The 0.4 mg/l increase, alone, equalled a PE of nearly 30,000. If allowance were made for the natural reduction in BOD that occurred in the reach, the actual waste load added would be considerably greater.

The Stickney Works treated effluent increased the BOD to 11.1 mg/l at SS 314.0, the highest average value found on the main channel of the waterway. This increase represented a PE of slightly more than 800,000.

From below the Stickney Works downstream to Lockport Dam (SS 291.1) the BOD decreased in a normal pattern. Between Lockport Dam and the Brandon Road Station (DP 285.8) the BOD increased, presumably reflecting the effects of wastes discharged from Joliet and vicinity. As noted in the section on "Special Studies," however, the Brandon Road location is not considered a suitable sampling station, and any quantitative conclusions based on results at this station would be subject to question.

The BOD results at the remaining two downstream stations indicate a slight reduction at DP 277.8 and a sharp reduction at IR 271.5. The sharp reduction results, in part at least, from dilution by Kankakee River with its lower BOD.

The BOD of the Calumet-Sag System showed a general tendency to rise from 3.8 mg/l near the Calumet Harbor (CA 332.6) to 6.4 mg/l near the confluence of the channel with the Chicago Sanitary and Ship Canal (CS 304.1). The only measured waste entering the channel was the Calumet Treatment Works treated sewage effluent, which was discharged at two points between LC 322.4 and CS 317.9. The BOD data at stations in this reach indicate far less BOD increase than the measured quantity of BOD added by the treatment plant, and further investigation is needed to clarify this situation. The hydraulic factors in this reach are extremely complex, and may account in part for the lack of correlation between plant effluent and stream BOD results. The Little Calumet River enters this reach and when flows in the Little Calumet are high following rainfall, reversals of flow can occur. The stream flow data indicate that reversal of flow did occur during the first six days of the study, with a portion of the flow from the Little Calumet flowing to the lake and the remainder flowing down the Calumet-Sag Channel to the Chicago Sanitary and Ship Canal.

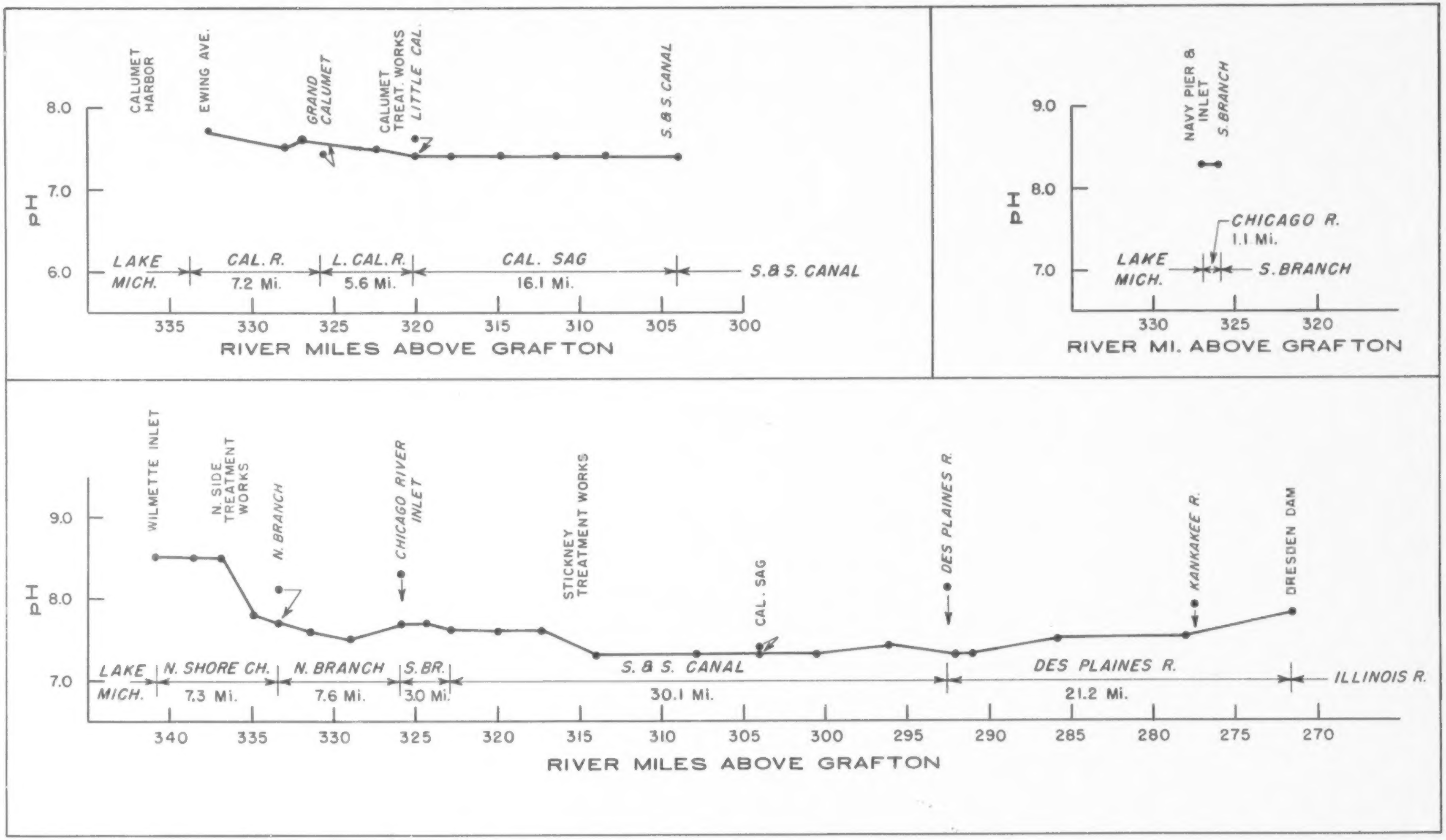
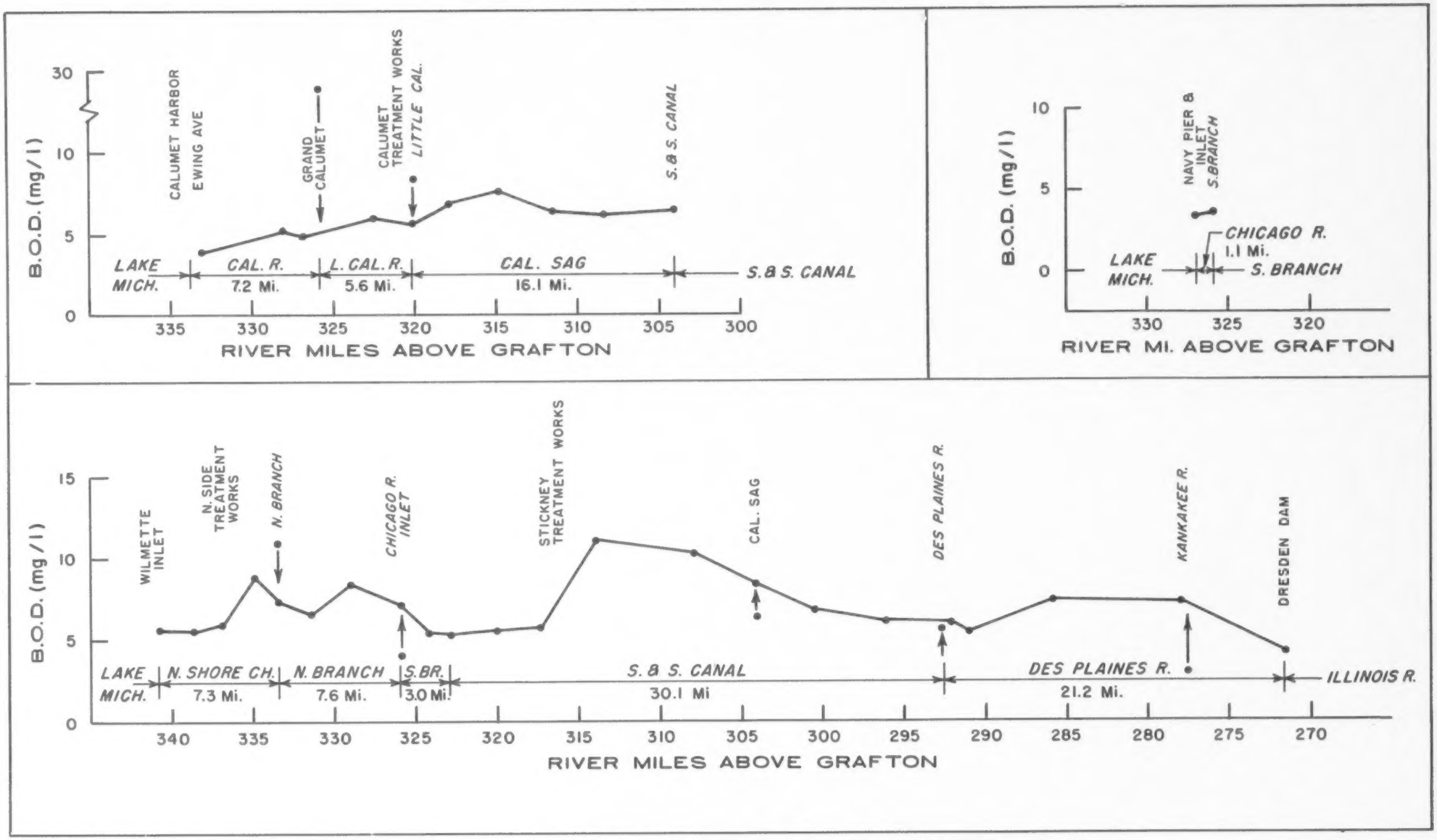


FIGURE 12

pH - AVERAGE VALUES
LAKE MICHIGAN - ILLINOIS RIVER BASINS
COMPREHENSIVE STUDY
APRIL 24 THRU. MAY 21, 1961

GPO 812422-19



BIOCHEMICAL OXYGEN DEMAND AVERAGES

LAKE MICHIGAN - ILLINOIS RIVER BASINS
COMPREHENSIVE STUDY
APRIL 24 THRU. MAY 21, 1961

FIGURE 13

In addition, the time of water travel data show that the water required several days to pass through the river reaches in this area. The stations below the treatment plant effluent discharge points were so far below the discharge points, in terms of time, that considerable reduction in BOD occurred between these points and the sampling stations.

In stream reaches other than that in the vicinity of the Calumet Treatment Works, the generally upward trend of the BOD averages from the upper to the lower end of Calumet-Sag System indicated that wastes probably entered the channel at numerous points along its course. There are many industries along the banks of the channel, some of which are known to discharge wastes to the stream.

At present it does not appear that the BOD data for the Calumet System can be analyzed and interpreted by normal procedures. More detailed examination of the data and of waste discharges may suggest means of interpretation, but it is probable that further investigation of the system will be necessary before a sound analysis of the situation can be made.

On the main channel of the Illinois Waterway there were several stream reaches that exhibited the typical BOD reductions below sources of wastes that natural purification accomplishes in a polluted stream. There were, however, other reaches in which the BOD either increased or remained fairly constant. It may be concluded that, in such reaches, organic wastes were being discharged to the waterway. In some of the reaches where the BOD failed to decrease there are no known records that wastes were being discharged.

The highest BOD average found in the waterway was 11.1 mg/l below the Stickney Treatment Works. Many of the other averages fell in the rather narrow range of 5.5 to 8.5 mg/l.

Dissolved Oxygen

The dissolved oxygen concentration of water at any point is the result of two opposing forces. One force is the BOD, which tends to reduce the DO below its natural level in an unpolluted stream. The other force is reoxygenation, which tends to increase the DO through solution of oxygen by absorption from the atmosphere and from oxygen produced by algae. Of the two oxygen sources, atmospheric reaeration is the more reliable and usually the more important. The DO from algae varies widely, as the concentration of algae and the intensity of sunlight fluctuate.

When BOD is low, the DO concentration usually is near the saturation level for the temperature involved. When the effects of other factors such as temperature and reaeration are equal, the greater the BOD the more the DO will be reduced. If the rate of BOD exertion is greater than the rate of reaeration over an extended reach of stream the DO may be totally depleted.

The average DO concentrations of the lake water entering the waterway at the Wilmette Control Works (NS 340.7) and at Chicago Harbor (CH 326.9) were near the saturation values for the temperatures involved (Figure 14). The DO of water in the waterway near Calumet Harbor (CA 332.6) was only 7.2 mg/l, or 68% of saturation. The reduced DO, along with the temperature, pH, and BOD, provide evidence that samples from this station did not represent unpolluted lake water.

Below the Wilmette Control Works the DO remained the same down to the next station (NS 338.6) but dropped 0.6 mg/l from there to the next station (NS 336.9), which is above the Northside Treatment Works. This decrease in DO supports the evidence of the BOD that waste from an unidentified source or sources enters this reach of the channel. Below the Northside Works (NS 334.9) the DO dropped 1.7 mg/l and continued to decrease downstream to NB 325.8, near the confluence of the North Branch with the Chicago River. At this point the DO was 5.0 mg/1, representing a decrease of 7.1 mg/1 from the 12.1 mg/1 at Wilmette. The DO contributed to the South Branch by lake water from the Chicago River temporarily raised the concentration 1.5 mg/1, to 6.5 mg/1 (SB 324.3), but from this point the decrease resumed and continued downstream in the Chicago Sanitary and Ship Canal to SS 317.3, just above the Stickney Works. Here the DO was 4.5 mg/1, representing a net drop of 7.6 mg/1 from Wilmette.

Below the Stickney Works, the DO continued to decrease, despite the oxygen contributed to the stream in the treatment plant effluent. This contribution averaged 52,000 pounds per day during the April 24 - May 6 period when the Stickney Works were sampled.

The decrease in DO continued downstream to the confluence with the Calumet-Sag Channel, being only 1.1 mg/l just above the confluence (SS 304.1). The oxygen contributed by the Calmet-Sag Channel maintained the DO of the Chicago Sanitary and Ship Canal at the same concentration just below the Calumet-Sag Channel (SS 300.5) as above.

Downstream from SS 300.5 the decrease in DO resumed, and continued to 0.6 mg/l at SS 292.1 in the Lockport Pool. This was the lowest average DO found along the main channel, and represented a net reduction of 11.5 mg/l from the DO concentration at the Wilmette Control Works. In view of the net reduction in DO throughout the length of the watercourse during relatively cool weather, there can be little, if any, doubt that the DO in the vicinity of the Lockport Pool will be zero during hot weather when the DO of lake water at the Wilmette Control Works probably will be not more than 9 mg/l, and possibly less. At the same time, the temperature of the waterway will be higher than it was during the study and the rate of BOD exertion will be more rapid.

It is possible that zero DO will occur in other stream reaches during hot weather. It is probable that such total oxygen depletion will occur in the Chicago Sanitary and Ship Canal above the Calumet-Sag Channel, and possibly it may occur in the Chicago Sanitary and Ship Canal above the Stickney Works, and in the North Branch above its confluence with the Chicago River. This conclusion is supported by the fact that zero DO was found on four days at Station SS 307.9 and five days at SS 304.1, above the Calumet-Sag confluence, in the period April 25 through 29, 1961.

Below SS 292.1, in the Lockport Pool, the DO remained the same down to Lockport Dam (SS 291.1). The average DO at the next downstream station, Brandon Road (DP 285.8) indicated a sharp increase to 7.8 mg/l. As noted in the section on "Special Studies", however, it is doubtful that this station is satisfactory, and the actual increase in DO probably is less than indicated by the data. This conclusion is supported by the DO of only 5.4 mg/l at the next downstream station, DP 277.8.

The 9.0 mg/l DO content of the Kankakee River contributed to the increase in DO of the main stream to 8.8 at the farthest downstream station, IR 271.5, below the Dresden Island Dam.

Every station in the 26 miles of the Chicago Sanitary and Ship Canal, from above the Stickney Works to Lockport Dam, had an average DO of less than 5 mg/l. An average of 5 mg/l of DO is accepted by many pollution control authorities as the minimum necessary to maintain desirable water quality and a healthy stream.

The relatively low DO of 7.2 mg/l at the upper end of the Calumet-Sag System (CA 332.6) decreased sharply to 3.2 mg/l at the next downstream station(CA 328.1). From this station throughout the Calumet-Sag System the DO fluctuated between 2.6 and 4.4 mg/l. At no station was the average DO as high as 5.0 mg/l. From the first station below the Calumet Treatment Works (CS317.9), where the DO was 3.6 mg/l, there was a steady drop to 2.6 mg/l at CS 308.4, followed by a slight rise to 2.8 mg/l at the station (CS 304.1) near the confluence with the Chicago Sanitary and Ship Canal.

Because of the uncertainties regarding the BOD data on the Calumet-Sag Channel, as discussed in the preceding section on BOD, it would be unrealistic at this time to attempt to correlate the DO data with sources of wastes discharged to the Calumet-Sag Channel. The low DO in the lower end of the Calumet-Sag Channel and its small contribution of DO to the Chicago Sanitary and Ship Canal, is of considerable significance.

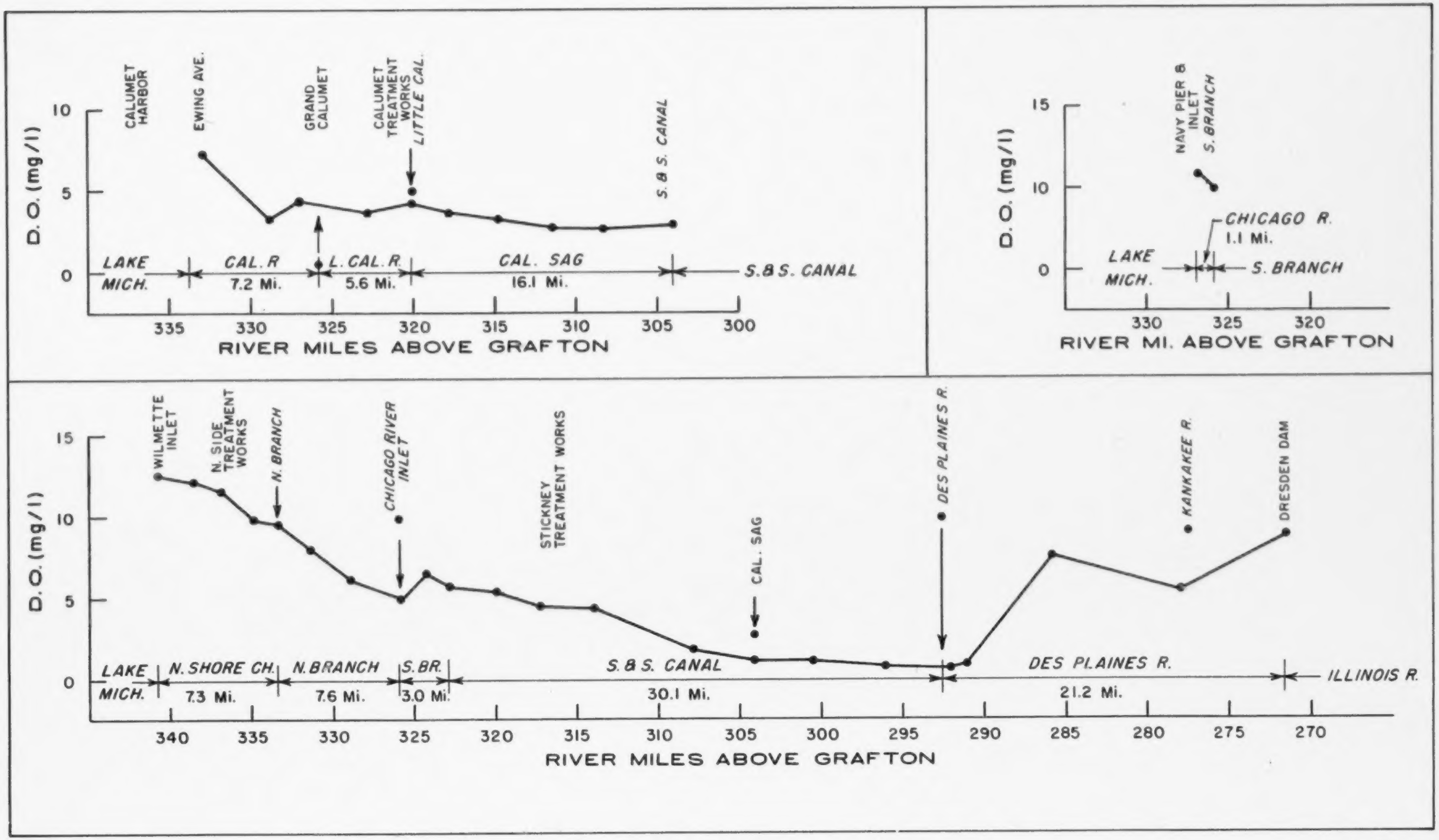
Throughout the waterway, the serious DO depletion that occurs results from the deoxygenation of the effluents from the three major sewage treatment works; of direct discharges of untreated or only partially treated sewage and industrial wastes, including storm water overflows; and of sludge deposits.

Coliform Bacteria

Coliform bacteria are typically found in water contaminated by sewage, and in such situations are indicative of the presence of pathogenic organisms. Many pollution control authorities accept an average of 5,000 coliform bacteria per 100 ml of water as the maximum permissible limit used for recreation, such as boating and fishing, which does not involve direct body contact with the water. By implication, at least,the same limit logically applies to water used for navigation.

At the Wilmette Control Works, the coliform

66-d



DISSOLVED OXYGEN AVERAGES

LAKE MICHIGAN - ILLINOIS RIVER BASINS
COMPREHENSIVE STUDY
APRIL 24 THRU. MAY 21, 1961

FIGURE 14

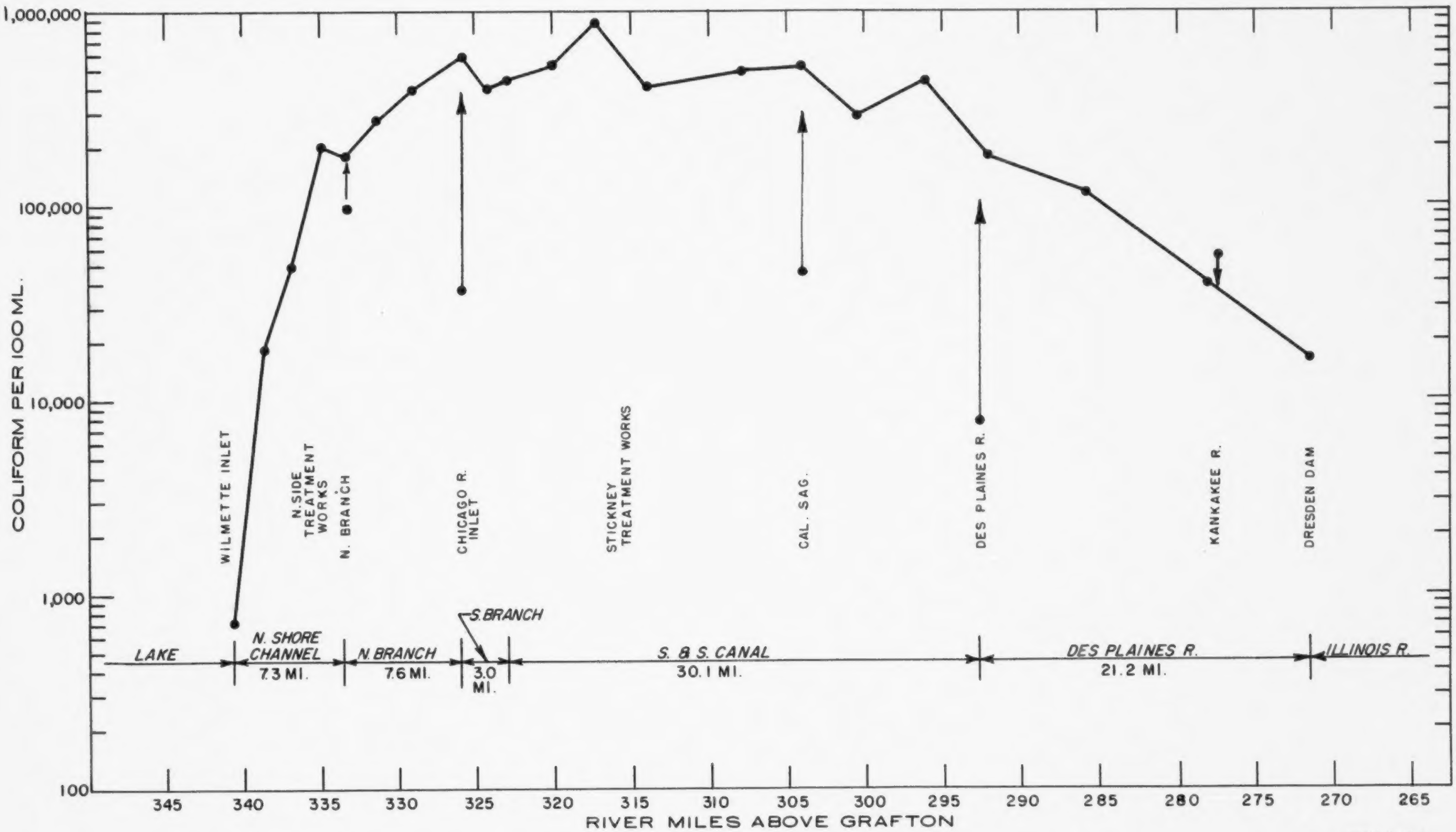


FIGURE 15A

COLIFORM AVERAGES

LAKE MICHIGAN - ILLINOIS RIVER BASINS
COMPREHENSIVE STUDY
APRIL 24 THRU MAY 21, 1961

66-b

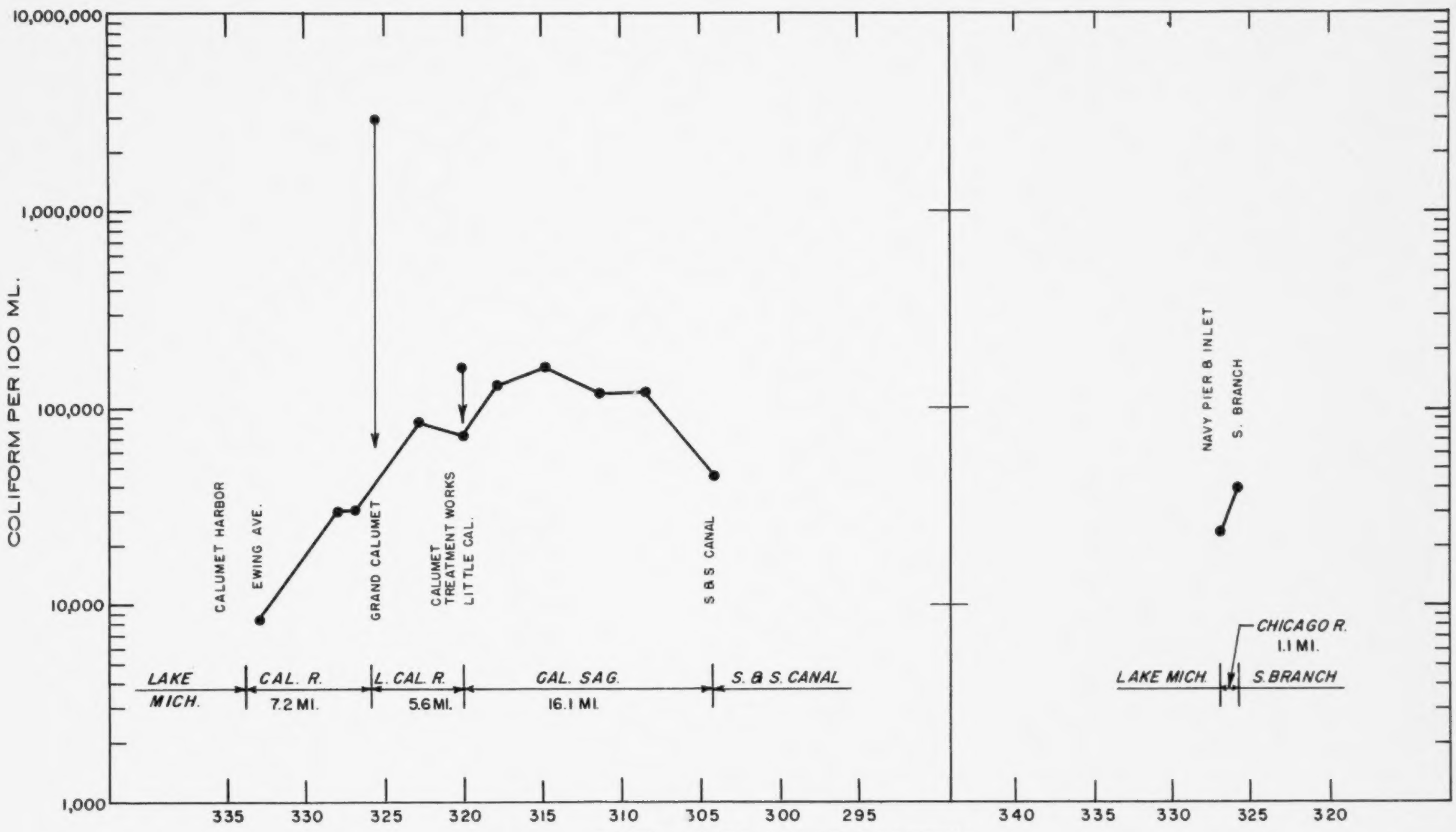


FIGURE 15B

COLIFORM AVERAGES

LAKE MICHIGAN - ILLINOIS RIVER BASINS
COMPREHENSIVE STUDY
APRIL 24 THRU MAY 21,1961

66-C

bacteria averaged 730 per 100 ml; at the Chicago Harbor, 22,000 per 100 ml; and at the station nearest Calumet Harbor, 8,500 per 100 ml (Figure 15A). At the Chicago Harbor, one extremely high result of 550,000 per 100 ml on a single day (April 26) accounted for the high average at that station (CH 326.9). If this single value were omitted, the average would be only 880 per 100 ml, which appears to be more reasonable value for this location.

Below the Wilmette Control Works the coliform bacteria increased to 49,000 per 100 ml at NS 336.9, just above the Northside Treatment Works. This concentration is equivalent to the coliforms contributed by the untreated sewage from a population of at least 9,200, which is in reasonable agreement with the 10,000 BOD PE added to this reach of the North Shore Channel, as discussed in the section on BOD. It is apparent that raw sewage is discharged to this section of the waterway, above the Northside Works. Visual observations of condoms, grease balls, and other evidences of sewage pollution confirm this conclusion.

Below the Northside Works, the coliform bacteria increased to 200,000 per 100 ml at NB 334.9, and continued generally to increase downstream, with minor fluctuations to a peak of 870,000 per 100 ml at SS 317.3, above the Stickney Treatment Works. At this point the the coliform bacteria were equivalent to those contributed by the raw sewage from a population of about 40,000 persons.

Below the Stickney Works the coliform bacteria decreased to 410,000 per 100 ml at SS 314.0, and then rose again to a peak of 520,000 per 100 ml at SS 304.1, just above the confluence of the Calumet-Sag Channel.

Below the Sag Channel the trend generally was downward, decreasing to 39,000 per 100 ml at DP 277.8, just above the Kankakee River. Below the Kankakee River confluence the coliform bacteria dropped still further to 16,000 per 100 ml at IR 271.3, below Dresden Island Dam. In the Calumet-Sag System, the coliform bacteria increased from 8,400 per 100 ml at CA 332.6 to 85,000 per 100 ml at LC 322.4, just above the Calumet Treatment Works (Figure 15B).

Below the sewage plant the coliform bacteria continued to rise to a peak of 160,000 per 100 ml at CS 314.9, near the upper end of the Calumet-Sag Channel. Below station CS 314.9 the trend of the coliform bacteria was generally downward to 45,000 per 100 ml at CA 304.1, near the lower end of the Calumet-Sag Channel.

Very shortly after the lake water enters the Illinois Waterway at all three points of diversion, sewage pollution increases the coliform bacteria to concentrations above the 5,000 per 100 ml generally considered to be the desirable upper limit of bacterial contamination. Throughout the remainder of the Waterway in the vicinity of the Chicago Metropolitan Area the coliform bacteria concentrations are many times the desired limit. The maximum value found, just above the Stickney Treatment Works, was 154 times the desirable limit.

BIOLOGICAL RECONNAISSANCE

The biological reconnaissance consisted basically of taking bottom animal and phytoplankton samples during April and May of 1961. Bottom animals reference life at fixed points while phytoplankton represent a transitory picture in a moving waterway. Twenty-four stations were sampled with dredges for bottom animals and twenty-nine stations for phytoplankton.

Phytoplankton
April - May 1961

Algal plankton enumerations were made on water samples from which bacteriological data were also gathered. The aliquot in which plankton were counted from was preserved in formaldehyde. The counts presented here (Figures 16 and 17) are based on water samples that were collected over a period of six hours on April 28 and on May 4, 1961. At Wilmette and Chicago Harbor, immediately below lockages, phytoplankton counts were highest. The numbers of phytoplankton per milliliter were suppressed once the flowing water carrying such suspended aquatic plants entered reaches where sewage treatment plant outfalls, storm water overflows and other wastes of man-made origin enter the Illinois Waterway in the reach under study. The counts are also suppressed at the Calumet Harbor entrance by industrial wastes, and remain suppressed in this tributary of the canalized system of waterways.

The plankton counts that were observed immediately within the lockages from Lake Michigan at Stations NS 340.7 and CH 326.9 are representative of the clearest water in the canal system of Greater Chicago. Degradation of water by pollution that results in lower counts at other stations reflects the presence of feces, garbage components, and oils, and other unidentified municipal and industrial wastes resulting from man's activities in the area.

Benthic Animals

Benthic animals provide a picture of the long term accumulated influences of pollution. Influx of organic material, low dissolved oxygen or high oxygen demand may not influence the majority of the organisms if these influences last for but a short time. A momentary passage of an industrial or agricultural toxicant, may destroy a group of organisms. Long term accumulations of minute amounts of undesirable materials are also reflected in the organisms.

The macrobenthic organisms provide major insights to water conditions. In clean water environments there are many kinds of organisms contributing to a low or moderate standing crop. Organic wastes may reduce the number of kinds of organisms, but those kinds that are capable of survival produce large standing crops because of the lack of competition and the increased organic food supply. If the environmental conditions become adverse from municipal, industrial or agricultural wastes, both the number and kinds of organisms are greatly reduced.

Twenty-four stations were sampled in the Greater Chicago Area (Table 25).

A gross examination of the benthic fauna of the Chicago Area reveals a most atypical situation. At no sampling station in the waters under control of the Chicago Sanitary District and the Des Plaines River between Lockport and Dresden Dam was there a clean water association of organisms. Conditions were very severe a short distance below the Wilmette and Chicago Harbor Lockages. The only moderation in severity of pollution, as indicated by the assemblages of organisms sampled, was in the areas immediately below the lockages at Wilmette and the Chicago Harbor.

At Stations NS 340.7 and CH 326.9 the biota present was the most diversified. The total standing crop was relatively small at Station NS 340.7 and moderate in size at Station CH 326.9. At Station CH 325.8 approximately the same associations of organisms were found, though sludgeworms were providing a larger portion of the standing crop.

Of note at Stations NS 340.7, CH 326.9 and 325.8 is the lack of clean water associated organisms. These organisms should be associated with clean water entering the system from Lake Michigan. The absence of these clean water associations indicate possible periodic severe conditions occurring when the intake of water from Lake Michigan is reduced, for the water in these areas becomes stagnated or polluted from water backing up from downstream areas.

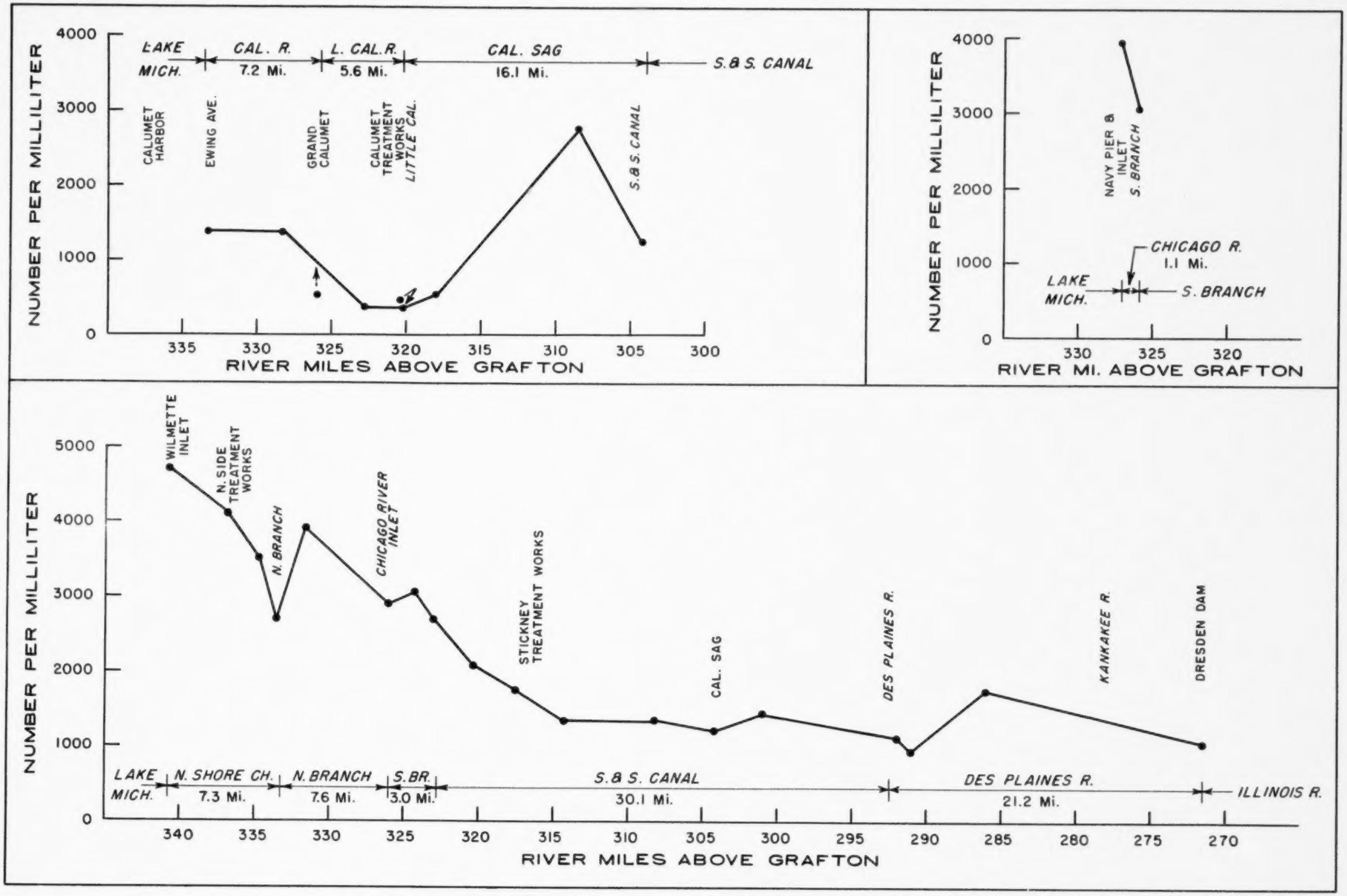
At other stations on the North Branch of the Chicago River-North Canal System and the Chicago Sanitary and Ship Canal, the diversity of organisms disappeared. Sludgeworms were the only benthic animals found with the exception of Stations NS 334.9 and SB 322.8. Station NS 334.9 had a few pulmonate snails; Station SB 322.8 had a few fingernail clams.

In areas of heavy organic loads or deposition (Stations NS 336.9, NB 331.4 and SS 314.0) the quantities of sludgeworms were greatly increased. In other areas (Stations SS 320.0, SS 317.3 and SS 307.9) only sludgeworms were present but in greatly reduced numbers. A most probable explanation of this reduction is the periodic occurrence of adverse conditions. Station SS 314.0 retained a high standing crop in this section of otherwise poor reduction.

In the Calumet Harbor Area only a few sludgeworms were found. Adverse conditions probably keep the standing crop of sludgeworms at a minimum level.

The Grand Calumet River is of particular interest (Station GC 325.8). At the Grand-Little Calumet River junction, the Calumet River was septic. Pollution here caused a deposition of black sludge on the bottom. Ebullition of decomposition gases constantly brought mats of partially decomposed organic matter up from the bottom.

Stations LC 322.4, LC 320.0, LC 320.2 were dominated by large standing crops of sludgeworms. A few bloodworms were also present at Stations LC 322.4 and LC 320.2. Station LC 322.4 exhibited the most organism diversity in the Calumet region; in addition to sludgeworms and bloodworms, leeches and fingernail clams were also found.



TOTAL PHYTOPLANKTON PER MILLILITER
LAKE MICHIGAN - ILLINOIS RIVER BASINS
COMPREHENSIVE STUDY
APRIL 28, 1961

FIGURE 16

68-a

68-b

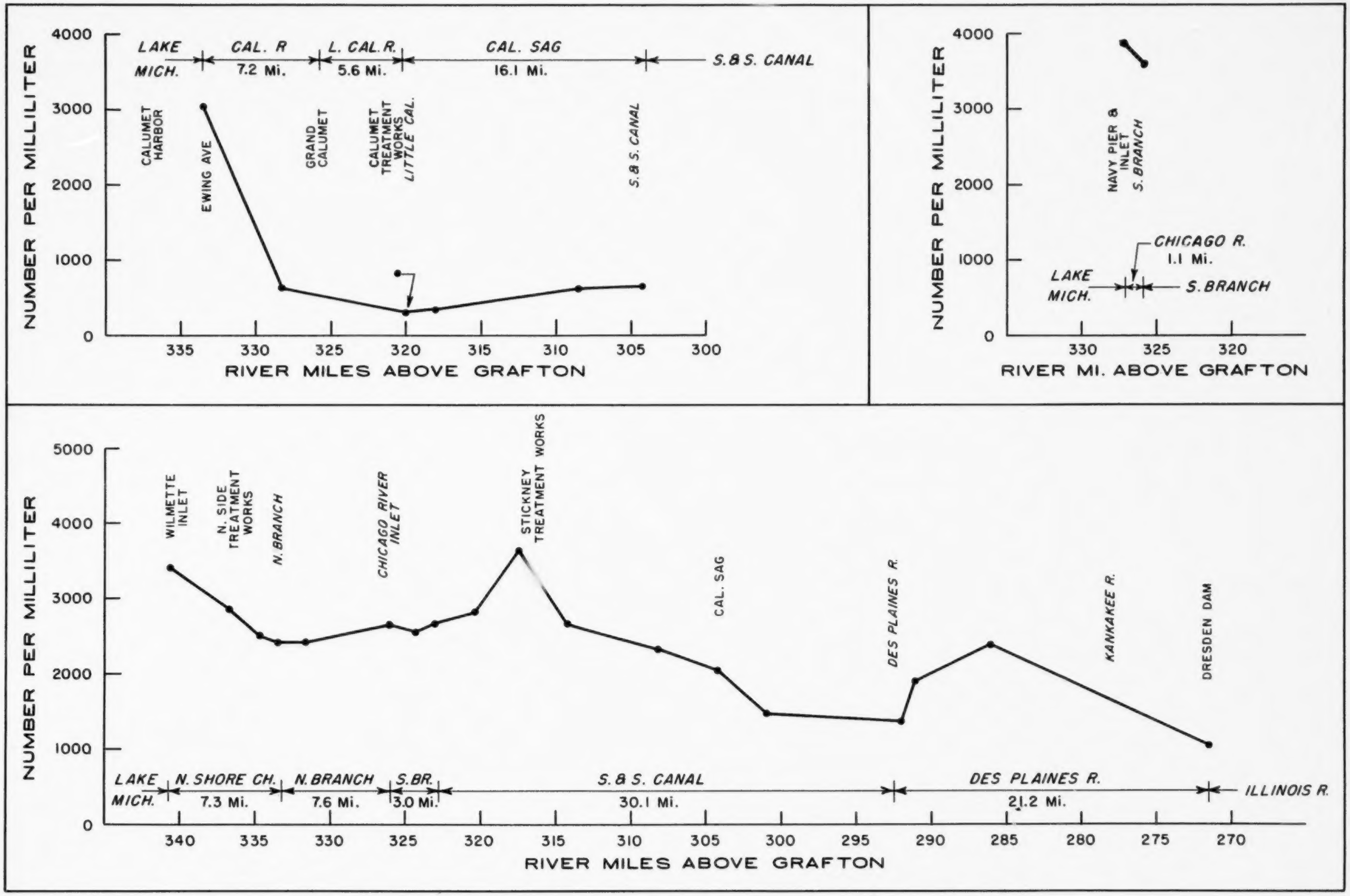


FIGURE 17

TOTAL PHYTOPLANKTON PER MILLILITER
LAKE MICHIGAN - ILLINOIS RIVER BASINS
COMPREHENSIVE STUDY
MAY 4, 1961

GPO 812422-|20

The Calumet-Sag (Stations CS 317.4 and CS 304.4) had low standing crops of sludgeworms only.

The Des Plaines River, above its junction with the Chicago Sanitary and Ship Canal, is moderately polluted; here snails, damselfly nymphs, fingernail clams, sludgeworms, leeches and crayfish were found. Upon junction with the Chicago Sanitary and Ship Canal, the River's macrobenthic fauna reverted to sludgeworms. In the Illinois River (Dresden Pool), a few bloodworms were associated with the sludgeworms.

The Kankakee River supports the only clean water association of organisms found during the reconnaissance. Populations of sludgeworms and bloodworms are minimal. A clean water association consisting of caddis flies, mayflies and damselfly nymphs was dominant.

SEWAGE TREATMENT WORKS STUDY

Evaluation of major sources of waste discharged to the waterway in the study area necessitated sampling of the effluents from the Metropolitan Sanitary District's three largest sewage treatment plants. These are: the Northside, Calumet, and West-Southwest (Stickney) Sewage Treatment Works.

Information was desired on the BOD, DO and coliform concentration in each plant effluent to permit correlation with stream data. Oxygen data on plant effluents was needed to appraise sources of oxygen contributed to the waterway. Coliform measurements were necessary to form another basis for evaluation of waterway pollution.

The Stickney Works influent and effluent were sampled for 13 days, April 24 to May 6 inclusive. The Northside and Calumet Works influent and effluent were sampled simultaneously for 13 days, May 9 to May 21 inclusive. The influent and effluent at each plant were sampled hourly and composited for each eight-hour period according to the hourly sewage flow.

Northside Works

The Northside Works is an activated sludge plant with an average design capacity of 250 MGD and a maximum capacity of 375 MGD. During the 13-day period, May 9 to May 21 inclusive, the average daily flow was 231 MGD, the maximum daily flow 284 MGD, and the minimum daily flow 209 MGD (Table 27).

Samples of raw sewage were taken from the entrance to the grit removal units. The average daily raw BOD was 122 mg/l, with a maximum daily average of 157 mg/l and a minimum daily average of 94 mg/l. Samples of effluent were taken from the plant outfall sewer as the flow entered the North Shore Channel. Effluent BOD averaged 10.8 mg/l with a maximum daily average of 14.1 mg/l and a minimum daily average of 8.2 mg/l.

The average plant efficiency in terms of BOD removal was 91.1 percent for the study period. Effluent dissolved oxygen averaged 8.4 mg/l with a maximum daily average of 8.8 mg/l and a minimum daily average of 8.0 mg/l. The average concentration of coliforms per 100 ml was 689,000, with a maximum daily average of 1,035,000 and a minimum daily average of 342,000.

Calumet Works

The Calumet Works is an activated sludge plant with an average design capacity of 136 MGD and a maximum capactiy of 210 MGD. During the 13-day period from May 9 to May 21 inclusive, the average flow was 138 MGD, the maximum daily flow 157 MGD and the minimum daily flow 119 MGD (Table 28).

Samples of raw sewage were taken at the entrance to the grit removal units. The average raw BOD was 126 mg/l with a maximum daily average of 150 mg/l and a minimum daily average of 105 mg/l.

Samples of effluent were taken from the plant outfall sewer at the new gatehouse located southwest of battery "A" final settling tanks. Effluent BOD averaged 13.5 mg/l with a maximum daily average of 17.3 mg/l and a minimum daily average of 10.6 mg/l. The average plant efficiency, in terms of BOD removal, was 89.2 for the study period.

Effluent dissolved oxygen averaged 6.8 mg/l with a maximum daily average of 7.3 mg/l and a minimum daily average of 6.3 mg/l.

The average concentration of coliforms per 100 ml was 302,000 with a maximum of 674,000 and a minimum of 133,000.

TABLE 27
THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO
SURVEY OF NORTHSIDE SEWAGE TREATMENT WORKS
BY U.S. PUBLIC HEALTH SERVICE MAY 9 TO MAY 21, 1961

		INFLUENT				EFFLUENT									
			BOD				BOD					DO			
May 1961	Flow MGD	pH	mg/1	Tons/ day	PEx10^3	pH	mg/1	Tons/ day	PEx10^3	% Rem.	Temp.	mg/1	Tons/ day	% Sat.	Coliforms/ 100 mlx10^3
9	235	7.4	122	120	1,444	7.2	12.4	12.2	146	89.8	13.0	8.1	7.9	76.4	743
10	225	7.5	114	106	1,272	7.5	11.2	10.5	126	90.1	12.9	8.3	7.8	78.2	713
11	229	7.6	125	119	1,428	7.3	13.1	12.5	150	89.2	13.7	8.3	7.9	79.3	1,030
12	234	7.6	119	116	1,392	7.5	10.6	10.4	125	91.0	14.6	8.1	7.6	78.8	403
13	236	7.6	123	121	1,452	7.4	11.9	11.7	140	90.2	15.2	8.3	8.1	81.7	463
14	225	7.5	94	88	1,056	7.6	9.2	8.6	103	90.3	15.2	8.3	7.8	81.7	343
15	285	7.4	157	187	2,244	7.3	12.5	14.8	177	92.0	14.7	8.0	9.5	78.0	513
16	224	7.8	104	97	1,164	7.6	10.5	9.8	117	89.8	13.7	8.6	8.0	82.2	1,020
17	229	7.7	129	123	1,476	7.5	8.8	8.4	101	93.1	13.2	8.5	8.1	80.5	827
18	219	7.7	131	119	1,428	7.5	8.2	7.5	90	93.6	13.7	8.5	7.8	81.3	900
19	219	7.6	123	112	1,344	7.5	9.1	8.3	99	92.6	13.6	8.6	7.9	82.1	573
20	228	7.6	120	114	1,368	7.4	8.9	8.5	102	92.4	13.6	8.5	8.1	82.1	743
21	209	7.5	125	109	1,308	7.6	14.6	12.7	152	89.2	13.2	8.6	7.5	81.4	670
Total	2,997			1,531	18,372			135.9	1,628				104.0		
Avg.	231	7.6	122	118	1,413	7.4	10.8	10.5	125	91.0	13.9	8.4	8.0	80.3	688
Max.	284	7.8	157	187	2,244	7.6	14.6	14.8	177	93.6	15.2	8.6	9.5	82.2	1,030
Min.	209	7.4	94	88	1,056	7.2	8.2	7.5	90	89.2	12.9	8.0	7.5	76.4	343

TABLE 28

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO
SURVEY OF CALUMET SEWAGE TREATMENT WORKS
BY U.S. PUBLIC HEALTH SERVICE MAY 9 TO MAY 21, 1961

INFLUENT						EFFLUENT									
			BOD				BOD					DO			
May 1961	Flow MGD	pH	mg/1	Tons/ day	PEx10^3	pH	mg/1	Tons/ day	PEx10^3	% Rem.	Temp.	mg/1	Tons/ day	% Sat.	Coliforms/ 100 mlx10^3
9	157	7.3	119	77.7	932	7.2	14.5	9.5	114	87.8	13.6	7.2	4.7	68.7	247
10	148	7.3	136	84.1	1,009	7.3	10.7	6.6	79	92.2	13.6	7.1	4.4	67.8	428
11	150	7.5	150	93.6	1,123	7.4	12.3	7.7	92	91.8	14.3	7.0	4.4	67.7	212
12	143	7.4	120	71.4	857	7.4	11.2	6.7	80	90.7	14.9	6.9	4.1	67.5	230
13	144	7.4	111	66.8	802	7.3	11.0	6.6	79	90.1	15.2	7.1	4.3	69.9	203
14	133	7.5	105	58.2	698	7.4	10.6	5.9	71	89.9	15.2	6.9	3.8	67.9	133
15	148	7.5	135	83.6	1,003	7.5	13.3	8.2	98	90.2	14.7	7.0	4.3	68.2	206
16	132	7.5	120	65.8	790	7.6	17.3	9.5	114	85.5	14.8	6.6	3.6	64.5	304
17	130	7.4	115	62.2	746	7.4	16.0	8.7	104	86.0	14.6	6.4	3.5	62.3	210
18	135	7.4	143	80.7	968	7.4	15.6	8.8	105	89.1	14.8	6.3	3.5	61.5	231
19	129	7.5	147	79.0	948	7.5	16.2	8.7	104	89.0	14.9	6.2	3.3	60.7	422
20	124	7.3	130	67.1	805	7.3	15.1	7.8	93	88.4	14.8	6.1	3.2	59.6	674
21	119	7.6	106	52.5	630	7.5	12.1	6.0	72	88.6	14.5	6.8	3.4	66.0	429
Total	1,792			942.7	11,311			100.7	1,205				50.5		
Avg.	138		126	72.5	870		13.5	7.7	93	89.2	14.6	6.7	3.9	65.6	302
Max.	157	7.6	150	93.6	1,123	7.6	17.3	9.5	114	92.2	15.2	7.2	4.7	69.9	674
Min.	119	7.3	105	52.5	630	7.2	10.6	5.9	71	85.5	13.6	6.1	3.2	59.6	133

West-Southwest (Stickney) Works

The Stickney Works is a combination of two types of sewage treatment plants, the Westside Imhoff Plant and the Southwest Activated Sludge Plant operating together as a unit. The results of the study are shown in Table 29.

The Westside Plant is designed for an average flow of 472 MGD and a maximum of 690 MGD. The Southwest Plant is designed for an average flow of 428 MGD and a maximum of 810 MGD. When the two plants are operating combined as a unit, the average design flow is 900 MGD and the maximum is 1,200 MGD. Each plant gives preliminary treatment to the portion of raw sewage reaching that plant through a combination of interceptor sewers serving different areas of the Sanitary District. The preliminary treated sewage entering the Southwest aeration tanks consisted of 46 percent from the Westside Imhoff tanks and 54 percent from the Southwest preliminary tanks.

The raw sewage flow to the Westside Plant, with the addition of Southwest Plant preliminary sludge, is settled in Imhoff tanks. The sludge from the Imhoff tanks is dried on sludge drying beds, or pumped to sludge lagoons or to the Southwest sludge concentration tanks. The Westside Imhoff effluent, together with sludge from the Northside Works, flows to the Southwest aeration tanks and leaves the Works after secondary treatment via the Southwest effluent sewer. The waste activated sludge from Southwest is concentrated, vacuum-filtered, and dried for storage or shipment.

The sewage flow to the Southwest Plant is settled. The settled sludge from the preliminary settling tanks is discharged to the Salt Creek interceptor to the Westside Plant, and the preliminary effluent, together with the Westside effluent and Northside sludge, is treated by activated sludge process.

The raw sewage samples from the two plants were composited each hour according to the flow to each plant. At the Westside Plant, the raw sample was taken from the flume between the raw sewage pump discharge and the bar screens, and included the Southwest preliminary sludge. At the Southwest Plant, the raw sample was taken from the north and south flumes between the raw sewage pump discharge and the preliminary tanks. The samples from the two flumes were combined in equal quantities before compositing with the Westside sample. The one raw sample thus obtained included a double measurement of Southwest preliminary sludge; therefore, the BOD removed by the Southwest preliminary was deducted from the BOD as measured. This deduction was computed from the difference in BOD between the Southwest raw and the Southwest preliminary effluent, as reported by the Southwest laboratory, and tabulated in tons of BOD as shown in Column 9 of Table 30. The total treated flow from the Stickney Works averaged 852 MGD which was made up of 459 MGD from Southwest Plant and 393 MGD from Westside Plant. The maximum daily treated flow was 1,125 MGD and the minimum daily was 704 MGD. On April 24, 41 million gallons, and on April 25, 44 million gallons of Westside settled sewage was discharged to the Chicago Sanitary and Ship Canal without secondary treatment. The influent to the Works averaged 505 tons of BOD per day and the effluent averaged 60 tons BOD giving a plant removal efficiency of 88.2 percent for the 13 days of sampling.

The effluent dissolved oxygen averaged 7.2 mg/l with a maximum daily average of 8.0 mg/l and a daily minimum of 6.8 mg/l.

The concentration of coliforms per 100 ml averaged 834,000 with a daily maximum of 1,904,00 and a daily minimum of 171,000.

TABLE 29
THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO
SURVEY OF WEST-SOUTHWEST SEWAGE TREATMENT WORKS
BY U.S. PUBLIC HEALTH SERVICE APRIL 24 TO MAY 6, 1961

Date 1961 (1)	Week Day (2)	INFLUENT									
			FLOW-MGD			BOD					
		pH (3)	SW (4)	WS (5)	Total (6)	mg/1 (7)	Total Tons (8)	Pri-Slu. WS (9)	Conc. Tank SW (9a)	Corr. Raw Tons (10)	PE 10^3 (11)
April 24	Mon.	-	507	443	950	174	690	44	39	607	7,284
25	Tue.	7.6	663	516	1,179	142	697	70	45	582	6,984
26	Wed.	7.6	485	460	945	188	742	78	46	618	7,416
27	Thu.	7.5	450	469	919	174	668	44	50	574	6,888
28	Fri.	7.3	429	497	926	164	632	101	49	482	5,784
29	Sat.	7.4	459	308	767	123	392	111	0	281	3,372
30	Sun.	7.5	444	271	715	97	290	35	0	255	3,060
May 1	Mon.	7.6	505	310	815	150	511	83	29	399	4,788
2	Tue.	7.4	429	374	803	170	570	46	1	523	6,276
3	Wed.	7.3	438	394	832	186	646	16	9	621	7,452
4	Thu.	7.3	449	392	841	202	707	37	60	610	7,320
5	Fri.	7.4	419	377	796	182	604	51	32	521	6,252
6	Sat.	7.5	421	389	810	174	588	97	0	491	5,892
Total		-	6,098	5,200	11,298	-	7,737	813	360	6,564	78,071
Average			469	400	869	163.5	595	62	28	505	6,005
Maximum		7.6	663	516	1,179	202	742	111	60	621	7,452
Minimum		7.3	419	271	715	97	290	16	0	255	3,060

Date 1961 (1)	Week Day (2)	EFFLUENT												
			FLOW-MGD			BOD					DO			Coliform/ 100ml in Thousands (24)
												Sat		
		pH (12)	SW (13)	WS (14)	Total (15)	mg/1 (16)	Tons (17)	PE 10^3 (18)	Rem % (19)	Temp °C (20)	mg/1 (21)	% (22)	Tons (23)	
April 24	Mon.	-	497	402*	899	18.9	71	1,057*	86.4	13.8	7.7	73.8	29	171
25	Tue.	7.2	653	472**	1,125	30.5	143	1,935**	74.3	12.4	7.4	69.0	35	527
26	Wed.	7.2	474	460	934	14.3	55	660	91.6	14.0	7.3	70.2	28	414
27	Thu.	7.3	439	469	908	14.1	54	648	91.4	14.9	7.1	69.5	27	702
28	Fri.	7.1	418	497	915	20.5	78	936	85.3	14.4	7.0	67.8	27	762
29	Sat.	7.3	448	308	756	12.1	38	456	86.5	14.9	7.2	70.5	23	493
30	Sun.	7.3	433	271	704	11.6	34	408	86.6	15.0	7.7	75.5	23	384
May 1	Mon.	7.4	495	310	805	12.3	41	492	90.3	14.3	8.0	77.4	27	355
2	Tue.	7.3	420	374	794	9.4	31	372	94.1	15.2	7.2	70.9	24	600
3	Wed.	7.3	428	394	822	13.0	45	540	92.9	15.6	6.9	68.5	24	1,262
4	Thu.	7.2	439	392	831	15.6	54	648	91.9	15.9	7.0	69.9	24	2,121
5	Fri.	7.3	409	377	786	19.1	63	756	88.7	15.9	6.9	68.9	23	1,904
6	Sat.	7.3	411	389	800	21.4	71	852	85.5	16.1	7.0	70.2	23	1,146
Total			5,964	5,115	11,079	-	778	9,760					337	
Average			459	393	852	16.4	60	751	88.1	14.8	7.3	70.9	26	834
Maximum		7.4	653	497	1,125	30.5	143	1,935	94.1	16.1	8.0	77.4	35	2,121
Minimum		7.1	409	271	704	9.4	31	372	74.3	12.4	6.9	67.8	23	171

Col. (4) Incl. SW plt. concentration tank overflow.
(5) Incl. SW plt. preliminary sludge. (to be deducted in Col. 15).
(7) Composite W-SW influ, incl. SW prelim sludge in WS influent, and SW conc. tank overflow in SW influ.
(8) Incl. W-SW raw plus SW prelim sludge in West raw, and conc. tank overflow in SW raw.
(9) Tons BOD contributed to WS raw by SW prelim sludge.
(9a) Tons BOD contributed to SW raw by SW conc. tank overflow.
(10) Actual tons BOD in W-SW raw sewage, Col. 8 minus (Col. 9 plus Col. 9a)
(13) Raw sewage less SW prelim sludge.
(14) Raw sewage plus SW prelim sludge.
* 41 MG of WS settled sewage to SS Canal est. PE 205,000.
** 44 MG of WS settled sewage to SS Canal est. PE 218,000.
SW activated sludge concentration tank overflow, averaged 1 MGD, was returned to SW raw influent.

TABLE 30
STICKNEY WORKS
COMPUTATION OF TONS BOD REMOVED BY SW PRELIMINARIES AND DISCHARGED TO SALT CREEK INTERCEPTOR AHEAD OF WEST SIDE PLANT

Date (1)	Flow Raw-MGD (2)	BOD Raw-mg/1 (3)	Product Flow times BOD (4)	Flow Sett. MGD (5)	BOD Sett. mg/1 (6)	Product Flow times BOD (7)	Col. 4 minus Col. 7 (8)	Col. 8 times .00417 = tons (9)
April 24	507	141	71,487	497	-	-	-	44 est.
25	663	122	80,886	653	98	63,994	16,892	70
26	485	144	69,840	474	108	51,192	18,648	78
27	450	166	74,700	439	135	59,265	15,435	44
28	429	192	82,368	418	139	58,102	24,266	101
29	459	141	64,719	448	85	38,080	26,639	111
30	444	85	37,740	433	68	29,444	8,296	35
May 1	505	111	56,055	495	73	36,135	19,920	83
2	429	156	66,924	420	133	55,860	11,064	46
3	438	170	74,460	428	165	70,620	3,840	16
4	449	174	78,126	439	150	65,850	8,796	37
5	419	156	65,364	409	130	53,170	12,194	51
6	421	186	78,306	411	134	55,074	23,232	97
Average	469	149		459	118			62

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APPENDIX I

INTRODUCTION AND BACKGROUND

INTRODUCTION

The greatest single factor permitting development of our metropolitan, industrialized society has been the engineering control that provides for safe water supplies and for the treatment, conveyance and ultimate disposal of the used water. As the Nation grows in population and industry, the need for more precise handling of the waste waters will increase. The technology of treating and disposing of liquid wastes is generally founded on the ability of a natural body of water to convey and ultimately dispose of the treated effluent from any properly selected and operated waste treatment method.

THE WATER ENVIRONMENT

A body of water, a flowing stream, may be considered as living phenomena; food is digested and air is breathed. Under natural conditions organic and inorganic nutrients are received that feed the flora and fauna normal to the water environment. In this process, oxygen dissolved in the water is consumed and replaced by that breathed in or absorbed from the air above the water. Such a natural body of water remains in dynamic balance with sufficient dissolved oxygen to satisfy demands for digestion and to provide for propagation of aquatic life.

In the water environment, living organisms go through the life cycle in a manner similar to life existing in terrestrial surroundings. The physical characteristics and chemical qualtiy of the water are major influences on the type of organisms living in this water environment. In the purest of waters, there would be no life; hence, "purity" is only a relative term. The purest waters in nature are those newly precipitated from vapors in the upper atmosphere, and even these contain dissolved atmospheric gases and particulate nuclei. During passage to the earth's surface, rain water gathers impurities from suspended dust, solid and gaseous debris of combustion, bacterial life, and spores of fungi.

This process continues on the land. Organic and inorganic residues of plant and animal life are either dissolved from the upper layers of the soil and the forest loam or carried into the stream as insoluble suspended matter of surface wash. All of these natural materials are foreign to pure water; and even if they are unobjectionable, constitute stream pollution in a strict sense. Here also are the beginnings of natural aquatic life. The residues provide the nutrient bases for the development of bacteria, and microscopic animal and plant life which, in turn, are food for successive life stages, and for forms of increasing complexity as from worms, mollusca, and insect larvae, to the major fish life of the fresh and salt waters. Thus, these pollutional materials play their important role in the natural regimen of the stream.

Pollution of waters by the end products of our communal life and economic development is a problem created by the water-carriage of waste substances and the necessity for the transport of treated effluents from the site. Difficulties result from the discharge of too great a quantity of waste and treated effluents into a body of water. If the oxygen-demanding load exceeds the assimilative capacity of the body of water into which it is discharged, the waters become degraded, foul in odor, aesthetically objectionable, and devoid of fish life. The biology of the stream changes from biota typical of clean waters to forms able to survive in the absence of measurable oxygen. Ultimately, recovery gradually takes place below the degraded area; clean water biota appear, and once again the waters are ready to serve the higher multiple demands placed upon them.

The foregoing discussion deals primarily with substances subject to bacterial degradation. Superimposed upon this condition are the complex considerations of pathogenic organisms, toxic materials, long lasting and inert substances, and radioactivity.

The pathogenic organisms are of especial significance from the standpoint of public health. The measurement of coliform bacteria as an indication of sewage contamination and the presumptive presence of pathogenic organisms has long been accepted practice in the public health field. Coliform bacteria downstream from a source of sewage normally increase significantly and then exhibit the characteristic die-away under the influence of natural purification. Pathogenic bacteria may be controlled by sewage treatment including chlorination of the effluent from the treatment works.

PUBLIC HEALTH SERVICE INTEREST AND RESPONSIBILITY

The Public Health Service, oldest of the organizations which comprise the Department of Health, Education, and Welfare, is the principal health agency of the Federal Government. Through the Public Health Service, the Federal Government works with others to discover and apply knowledge that will help prevent disease and improve health. The programs of the Service are conducted in close partnership with other agencies of the Department, with the States and Territories, and with numerous voluntary organizations, industry, professional groups, institutions, and international agencies.

Historically, the public health movement in the United States began in 1850 with the publication of the "Report of the Sanitary Commission of Massachusetts." This document recognized the need to regulate the public health, establish State and local Health Departments, and outlined a remarkably complete program even in terms of today's requirements.

It was not until the turn of the century, however, when water-borne diseases were occurring at an alarming rate, that the Public Health Service studies in water pollution had their beginnings. By 1910 the first systematic, large scale, area-wide investigation of water pollution was undertaken by the Service. Significantly, the assignment involved a survey of communities of the Great Lakes region with an aim towards investigating the extent of pollution of public water supplies and the relationship of polluted water to the prevalence of typhoid fever and other water-borne diseases.

The Public Health Act of 1912 granted the Service specific authority to conduct surveys and studies in water pollution, particularly as such pollution affected human health. In 1913, a Stream Pollution Investigation Station, predecessor of the present Robert A. Taft Sanitary Engineering Center, was established in Cincinnati, Ohio.

In 1948, after nearly a half-century of evaluating the growing water pollution problems, the 80th Congress passed the Water Pollution Control Act, Public Law 845. Administration of the Act was placed in the Public Health Service. This Act delineated the principle of Federal-State cooperation and provided a Federal role of research, technical assistance, limited authority over interstate streams, and financial aid.

Out of the Act of 1948 emerged Public Law 660, 84th Congress, the Federal Water Pollution Control Act of 1956, the present authority. The new Act improved and extended the Service's activities by adding several new elements to its pollution abatement responsibilities. In authorizing a Federal Water Pollution Control Program, Congress clearly emphasized that primary responsibility in this field rests with the States. The Federal Government serves in a supporting role, but with certain leadership responsibilities, too, in view of the effects of pollution on public health and natural resources.

One part of Public Law 660, with immediate bearing on the work encompassed by this report, is Section 2 which is concerned with comprehensive programs for water pollution control. This section directs the Public Health Service to develop, in cooperation with State and interstate agencies and with municipalities and industries involved, comprehensive programs for eliminating or reducing the pollution of interstate waters and for improving the sanitary conditions of surface and underground waters.

The Act specifies that in the development of such programs, due consideration be given to all uses - public water supply; propagation of wildlife, fish and other aquatic life; recreational purposes; and agricultural, industrial, and other legitimate uses. The discharge of these and other responsibilities under the law is centered in the Service's Division of Water Supply and Pollution Control.

THE LAKE MICHIGAN-ILLINOIS WATERWAY

To comprehend the Great Lakes-Illinois Water diversion at Chicago, it is important to review some of the salient points of the origin and development of the network of artifical canals and channels in the Metropolitan Chicago Area (Figure2). These canals and channels, and the water flowing through them, form the basic raw ingredients of a controversy that has continued practically at an unmitigated tempo for over 60 years.

Events leading up to the construction of the first canal, the Illinois and Michigan Canal, are traced back to many decades ago. The need for this canal stemmed from a desire of early navigators for a link between the Great Lakes and the Illinois River. At this time, it was thought that this link would be satisfied by the construction of a canal that would cross the divide between the Chicago River, then a tributary of Lake Michigan, and the Des Plaines River, a summit eight feet above the lake. The canal would continue on to LaSalle, Illinois at which point it would enter the Illinois River for a direct route from the Great Lakes to the inland empire. Such a canal was finally completed in 1848. Over the years various improvements, enlargements, and experiments were undertaken with the canal. Some of the experiments involved utilizing the canal in attempts to solve Chicago's mounting waste disposal problem. The effects of a torrential rainstorm on August 2 and 3 of 1885 proved that the Illinois and Michigan Canal was not the answer to the city's sewage problem.

In 1885, the City of Chicago, with a population of 750,000, discharged its sewage untreated to the Chicago River through a number of large outfall sewers. As a result of an August storm that year, a great mass of storm water and sewage entered the Chicago River and emptied into the lake. This flow reached out beyond the city's water supply intake stations. The typhoid epidemic which followed touched off the appointment of a Commission to develop a plan to handle waste disposal and to protect the city's populace from water-borne diseases caused by a polluted water supply.

In substance, the final plan advocated pushing the Des Plaines River to the west side of its valley; digging a 28 mile drainage canal (known as the Main Channel of the Chicago Sanitary and Ship Canal) from the Chicago River at Damen Avenue to the Des Plaines River at Lockport, Illinois; making the Chicago River and the new canal flow away from the lake, and finally, the construction of intercepting sewers along the lakefront for the discharge of wastes into the drainage canal. This would eventually result in the abandonment of the Illinois and Michigan Canal. To implement the Commission's plan, the forerunner of today's Metropolitan Sanitary District of Greater Chicago was created on January 18, 1890. The geographical area covered by the Sanitary District today has grown roughly six-fold since its creation. The District now has jurisdiction over waste disposal in practically the entire area and population of Cook County and encompasses many political subdivisions.

Construction of the Main Channel began in 1892. Upon completion in 1900, it was ready to carry a normal flow of up to 10,000 cubic feet per second with a flow pattern suitable for navigation. In addition to carrying sewage away from the lake, the Channel was designed to serve as a larger, more useful inland waterway route from Chicago to the Mississippi River with provisions for a minimum depth of 9 feet (24 feet in Greater Chicago) as compared to the Illinois and Michigan Canal average of about 6 feet.

The remaining links in the canal system were finished in 1910 and 1922 with the opening of the North Shore Channel and Calumet-Sag Channel respectively. The eight mile long North Shore Channel extends from Lake Michigan at Wilmette, Illinois, to the North Branch of the Chicago River below Foster Avenue. The primary uses of this Channel today are to serve as a flood water outlet, to divert water from the lake, and to receive the effluent from the District's North Side Sewage Treatment Works. The last canal, known popularly as the Cal-Sag, also diverts water from the Lake, drains the District's south side, receives the effluent from the Calumet Treatment Works, and extends about 16 miles westward from the Little Calumet River at Blue Island, Illinois, to the Main Channel at Sag.

Chicago's permanent diversion of water from one watershed, the Great Lakes Basin, into another, the Illinois River Basin, has been a matter of constant attention. Parenthetically, Chicago's sewage collection and disposal was based on the dilution of wastes by the diversion of three and one-third cubic feet per second of water for each thousand inhabitants. In view of the normal capacity of the Main Channel, Chicago thought that the dilution method would be sufficient without waste treatment until the area's population reached 3,000,000.

The first legal action against operation of the canal system was filed in 1900 by the State of Missouri at about the same time the Main Channel opened. Missouri sought an injunction from the United States Supreme Court on the grounds that Chicago's dilution method of sewage disposal would empty wastes into the Mississippi River, thus endangering the water supply and public health of the City of St. Louis. This action was dismissed without prejudice by the Supreme Court in 1906.

Repeated requests by the Sanitary District to the Secretary of War for an extension of the diversion rate culminated in legal action by the Secretary to enjoin the District from diverting more water. These suits, brought in 1908 and 1912, were consolidated into a single action that ended in a 1923 decision upholding the Secretary. The United States Supreme Court sustained this decision two years later. By this time diversion had reached 8,500 cfs.

Meanwhile, in 1922 a number of Great Lakes States joined to bring suit in the United States Supreme Court to end the existing diversion at Chicago. In 1930, the Court issued a decree directing the Sanitary District to reduce its diversion to 1,500 cfs, plus domestic pumpage (which now averages 1,700 - 1,800 cfs) by the end of 1938. To meet the terms of the decree, the District engaged in a massive construction program designed to provide treatment for its wastes. This building program was substantially completed in 1949.

In addition to litigation, Chicago's diversion has also been the subject of considerable Congressional attention. In 1954 and 1956, Congress passed diversion bills allowing Chicago an additional 1,000 cfs. Both of these bills were vetoed by the President.

Litigation, however, was resumed again on June 29, 1959, when the Supreme Court directed the reopening of its 1930 decree. The present party litigants consist of the States of New York, Ohio, Minnesota, Pennsylvania, Michigan, and Wisconsin as plaintiffs and the State of Illinois and the Sanitary District as defendants.

In the current action, the plaintiffs ask that the defendants be required to return part or all of the Sanitary District effluent to the Great Lakes Basin from which it originally came in the form of "domestic pumpage." Alternatively the plaintiffs state that if the Court finds that measures other than the return of effluent to Lake Michigan can be put into effect to either reduce the direct diversion or limit domestic pumpage, the Court should enter a supplemental or modified decree to that effect. Succinctly stated, the aim of the plaintiffs is to reduce or restrict the total amount of diversion from the Great Lakes at Chicago.

Also before the Supreme Court at this time is a suit by the State of Illinois against the foregoing six Great Lakes States. This suit requests the Court to declare that the State of Illinois and its instrumentality, the Elmhurst-Villa Park-Lombard Water Commision, are entitled to proceed with a program for the construction of a water supply system for the withdrawal of water from Lake Michigan. The Court has been asked to restrain the Great Lakes States from interfering with the Water Commission's construction and withdrawal. Final action in this case has been deferred by the Court pending presentation of testimony on the issues pertaining to reopening the 1930 decree.

The Supreme Court appointed a Special Master, Albert B. Maris, a retired United States Circuit Court of Appeals Judge, to conduct hearings on the issues placed before the Court. Upon the conclusion of the hearings, Judge Maris will deliver his findings and recommendations to the Court.

The United States of America became a party to the proceedings on its own motion to intervene shortly after the actual hearings commenced. In its petition to intervene, the United States cited numerous interests in the waters of the Great Lakes and the St. Lawrence River watershed. These interests fall into the following main categories:

1. Navigation on the Great Lakes, the St. Lawrence Seaway, and the Illinois Waterway.
2. Maintenance of friendly relations with Canada.
3. Hydroelectric power development on the Niagara and St. Lawrence Rivers within the United States.

4. Protection of the property belonging to the United States, in and adjacent to the Great Lakes and connecting rivers and waterways.

5. Protection of public health and control of pollution of the Great Lakes and related interstate waters.

6. Promoting the general welfare of all the United States in the utilization of the Great Lakes - St. Lawrence system as one of the great natural resources of the Nation.

In commenting specifically on item No. 5, the petition of the United States stated, in part, that:

> ". . . Congress has, in connection with the exercise of jurisdiction over the waterways of the Nation and in consequence of the benefits resulting to the public health and welfare in the preservation and control of water pollution, expressed the concern of the United States for the elimination or reduction of the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters. Among other things, the Act provides a procedure by the United States, under the direction of the Surgeon General, for the abatement of pollution of interstate waters which endangers the health or welfare of persons in a State other than that in which the pollution occurs."

Many organizations, including the United States Public Health Service, have long recognized the need for intensive study of the Great Lakes Basin. Following the entry of the United States into the latest diversion litigation, the United States Department of Justice requested the Public Health Service to furnish such definitive data and information as would be helpful in advancing testimony pertinent to the complex issues before the Court. At about the same time Congress was considering an appropriation to permit a comprehensive study of the entire Great Lakes-Illinois River Basins by the Public Health Service. In September 1960 the President signed the Health, Education, and Welfare appropriations bill into law. This bill included $500,000 with which the Service was directed to undertake the initial phase of a contemplated over-all six year $12 million comprehensive study. Completion of the entire study, which is dependent upon the desires of the Legislative and Executive Branches, will result in the largest comprehensive water quality management program ever undertaken by the Service.

This interim report, comprising findings of the first phase of the study, officially called the Great Lakes-Illinois River Basins Project, is confined to the Greater Chicago area.

BACKGROUND

HISTORY

Throughout the ages, the area now known as Greater Chicago has been a crossroad to the inland mariners of North America. Lake Michigan was discovered in 1634 by Jean Nicolet who was in search of a water route to China.

When seven Frenchmen first set upon the Illinois River in their tiny birchbark canoes in 1673, they were near the end of a long journey in a story to be told and retold many times over. These Frenchmen - Louis Joliet, Father Marquette, and their five seemingly anonymous helpers-had been sent by the Governor General of Quebec to explore the Mississippi River area. The purpose of their mission was twofold: the hope of advancing the fur trade by discovering a new route to the Mississippi River, and the hope of spreading religion among the Indians.

Writing about the Illinois River in his journal, Father Marquette recorded:

> "We have seen nothing like the river that we enter as regards its fertility of soils, its prairies, and woods, its cattle, elk, deer, wildcats, bustards, swans, ducks, parroquets, and even beaver. There are many small lakes and rivers. That on which we sailed is wide, deep and still, for 65 leagues."

So was written the first impression that the hand of a white man had ever recorded of the Illinois River. These Frenchmen, as they dragged their canoe across the portage between the Des Plaines and Chicago Rivers, had discovered what was later to become a short cut from the Mississippi to the Great Lakes. Joliet recognized the ease with which man could journey from the Great Lakes to Florida "by cutting through but half a league of prairie."

The next momentous event in Illinois history occurred with the arrival of LaSalle,who, among other things, surveyed the portage in the 1680's. LaSalle's voice reached far and wide with his plans for a great midland empire.

The French influence remained strong in those early days. Trading posts and small villages were established along the river. Indian names were accepted for many locations throughout the region. Chicago, although not without some debate today, probably means the powerful wild onion; Illinois was derived from the name of the Illiniwek Indians, and Michigan means great lake.

The ties with France began to weaken when the Illinois territory was ceded to Great Britain by the Treaty of Paris in 1763. In 1778 George Rogers Clark made an easy conquest of the Illinois country on behalf of the Commonwealth of Virginia, and Virginia ceded its claim to the United States Government in 1784.

Meanwhile, the area that was to become the most dynamic in all Illinois was relatively quiet until some years after the Revolutionary War. The full impact of the significance of General Anthony Wayne's defeat of the Indians in 1794 at Fallen Timbers was yet to be seen. Shortly after Wayne's victory the Indians gave up all claims to large tracts of land northwest of the Ohio River. Included in these tracts was a land area six miles square at the mouth of the Chicago River. Today this is the heart of the City of Chicago.

A succession of men - Jean de Sable, the first permanent resident of Chicago; Captain John Whistler, the builder of Fort Deaborn at the mouth of the Chicago River; John Kinzie, a trader known as the Father of Chicago - loom large in Chicago's beginnings even before Illinois became a State in 1818 or before Chicago was incorporated as a town in 1833 with a population of 350.

As the Illinois area started to rise in prominence, voices were again heard advocating the the development of a navigable link between Lake Michigan and the Illinois River. One of the most powerful voices was that of a young Congressman, Daniel Cook, for whom Cook County was named. Cook vigorously championed the cause of building the Illinois and Michigan Canal. "This is a work", Cook declared, "in which the nation is interested and which the government should therefore aid in executing. As a ligament to bind the Union together, no work of the same magnitude can be more useful."

Cook's pleas, and really, Joliet's dreams, were answered when digging of the canal through the narrow divide began on July 4, 1836. Within two years over 2,000 men were cutting through dirt and rocks by hand and oxen. The great ditch finally opened for traffic in 1848. Chicago's mushrooming population had reached 28,000. By 1860, a dozen years later, over 100,000 persons lived in the teeming city.

As the city grew so did the complexities of its health problems. In 1854, a cholera epidemic swept the community and wiped out over five percent of the population. Following the construction of a sewer system discharging wastes into the Chicago River, experiments were undertaken to reverse the flow of the river. The idea was to make the Illinois and Michigan Canal serve the dual purpose of navigation and sewage disposal. These experiments were unsuccessful but before the end of the century such experiments did lead to the construction of the Chicago Sanitary and Ship Canal which is discussed at some length in another section of this report. Today Chicago ranks as the second largest city in the Nation with a population of over three and one-half million. The State of Illinois totals slightly over ten million persons. Well over half of the State's population resides within the confines of Metropolitan Chicago.

PHYSICAL DESCRIPTION

The importance of the Illinois River Basin (Figure 1) is emphasized by the fact that the Basin drains approximately one-half of the area comprising the State of Illinois. Of the total drainage area of 29,010 square miles, 1,000 square miles lie in Wisconsin, 3,200 in Indiana, and the remainder in Illinois. The Illinois River, formed by the junction of the Des Plaines and Kankakee Rivers some 45 miles southwest of Chicago, flows in a southwesterly direction 273 miles to its mouth on the Mississippi River at Grafton, Illinois. For the most part, the river lies near the western border of its watershed with the greater number of major tributaries approaching from the east. The Des Plaines River originates in southeastern Wisconsin west of the City of Racine and flows southerly for 110 miles to its junction with the Kankakee. The Kankakee River rises in northern Indiana south of the City of South Bend and is about 130 miles long. Other large tributaries of the Illinois are the Fox, Vermilion, Mackinaw, Spoon, Sangamon, La Moine, and Macoupin Rivers.

The natural watershed of the Illinois has been increased artificially by the construction of a canal and channel system in and adjacent to the City of Chicago. The main drainage canal cuts through the low divide between the Des Plaines and the Chicago River, naturally tributary to Lake Michigan, thereby reversing the flow of the latter stream and causing it to flow into the Des Plaines. The North Shore Channel serves as a diversion inlet and flood water outlet, and receives treated sewage from the North Side Sewage Treatment Works. Another artificial Chicago channel, the Calumet-Sag Channel, reversed the flow of the Calumet River, also naturally tributary to the lake. This Channel receives treated sewage from the Calumet Sewage Treatment Works and joins the Main Channel at a point called Sag.

Practically the entire River Basin has been glaciated. The lower reaches of the Basin are characterized by flat plains with deeply incised valleys while in the upper reaches there is a prevalence of rock bluffs and intervening plains. General land elevation of the prairie regions is 750 feet and the principal stream valleys are flat-bottomed some 150 to 250 feet below.

The minimum elevation of the divide between lake drainage and the Illinois Basin is only eight to ten feet at a point just west of Chicago. The over-all gradient of the Illinois River, about 85 feet in 273 miles with 18 feet in the vicinity of Marseilles, is a unique feature.

Although erosion is a widespread problem, the soils of the Basin are considered excellent except for the sandy area of the Kankakee Basin and at the junction of the Illinois and Sangamon Rivers.

The Basin's climate is especially suited to temperate zone crops, particularly grains. On the whole, there is a frost-free period of five months. Summers are relatively long and hot with an abundance of moisture. In the late autumn a sharp drop in temperature occurs. The Basin's temperature in the southern part approximates 52 degrees compared to 47 degrees in the northern region. Extreme ranges of 113 degrees above zero to 34 degrees below zero have been experienced within the Basin. Average annual precipitation ranges from 32 to 37 inches.

ECONOMIC DEVELOPMENT

The economic development of the Lake Michigan-Illinois River Basin area is at an advanced stage. This condition is manifested by the extent and variety of activities conducted in the area as well as the population concentrations. The Chicago Metropolitan Area is the apex of the economic structure. Chicago is the second largest city in the United States with a population of 3.55 million. The population of the eight-county Standard Metropolitan Statistical Area is 6.1 million. The Standard Consolidated Area, which includes the Chicago SMSA* and the Gary-Hammond-East Chicago, Indiana SM SA has a population of 6.79 million (Table 1). Each of these figures is based on United States Bureau of the Census 1960 data.

The importance of industrial activity in the Chicago SMSA is indicated by the fact that the value added by manufacture amounts to 8.5% of the United States total. Three of the Nation's largest steel mills are located here. Total steel making capacity is over 29 million tons annually, about 22% of the National capacity.

The Chicago SMSA is also an important transportation center with 34 railroads, including 20 trunk lines. Two principal airports serve 17 major airlines, some of which have international schedules. Chicago is also a leading trucking center.

As a United States financial center, the area ranks second only to New York City. It is also a major trading center, the seat of the grain exchange, the largest corn market, several large mail-order houses, and the warehousing, wholesaling, and distribution headquarters for much of the rural and small community area of Illinois and the Middle West.

Chicago is the major midwestern port for Atlantic shipping, via the Great Lakes and the St. Lawrence Seaway. Navigation extends southward through the canals to the Illinois and the Mississippi Rivers. The comparatively low cost transportation advantage for bulk products is an important factor in the economy.

During the 1959 shipping season, over 3,300 ocean and lake vessels from the St. Lawrence Seaway went through the Welland Canal. Over one-third of these, carrying 60% of the total Seaway tonnage could not have used the old St. Lawrence system. Despite some adverse factors such as the late spring thaw, the steel strike after midyear, the general sluggishness of United States exports, delays and congestion at ports and locks, lack of mooring facilities at the Welland Canal between Lakes Ontario and Erie, and the unfamiliarity of the channels to ocean ships' pilots, the tonnage attributed to the Seaway in 1959 increased by 29% over 1958 to 27.4 million tons. The tonnage increase of 1958 over 1957 was 22%. Grain, coal, and iron ore composed the chief components of this water-borne shipping. Over two million tons of cargo passing through the Welland Canal loaded or unloaded at Chicago. Chicago waterborne exports in 1959 increased almost 170% over the preceding year while imports increased 117%.

In addition to these factors in the immediate Chicago Metropolitan Area, the influence of the hinterland is of major significance. The State of Illinois ranks second in the United States in agricultural production, first in soybeans, second in field corn, and third in sweet corn. Beyond Illinois is the dairying area of Wisconsin and Minnesota, the immense breadbaskets of Indiana, Iowa, Nebraska, and Kansas, and the major metropolitan areas of Milwaukee, St. Louis, Kansas City, Minneapolis - St. Paul, Indianapolis, and Memphis which interact with this vast metropolis.

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* Standard Metropolitan Statistical Area

TABLE I
1960 POPULATIONS
STANDARD METROPOLITAN STATISTICAL AREA
LAKE MICHIGAN AND ILLINOIS RIVER BASINS(a)

	SMSA Total	Total Urbanized Population	Urbanized Central City	Fringe	Outside of Urbanized Area
Chicago and N. W. Indiana(b)	6,795,000	6,213,000	3,550,000	2,663,000	582,000
% Change 1950-60	21%	21%	-2%	77%	24%
Milwaukee	1,194,000	1,149,000	741,000	408,000	45,000
% Change 1950-60	25%	39%	16%	112%	-64%
Racine	142,000	97,000	89,000	8,000	45,000
% Change 1950-60	29%	27%	25%	50%	31%
Kenosha	101,000	73,000	68,000	5,000	28,000
% Change 1950-60	34%	12%	25%	-52%	166%
Muskegon	150,000	95,000	66,000	29,000	55,000
% Change 1950-60	24%	12%	-2%	63%	50%
Peoria	289,000	181,000	103,000	78,000	108,000
% Change 1950-60	15%	17%	-8%	83%	12%

(a) Based on U. S. Bureau of Census data and population tables appearing in "Business Conditions": a Review by the Federal Reserve Bank of Chicago. (Monthly) (1960-1961).

(b) Data on this line are for the Standard Consolidated Area which includes the Chicago, and Gary, Hammond and East Chicago Standard Metropolitan Statistical Areas. All other lines are for the Standard Metropolitan Statistical Areas only.

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APPENDIX II

ORGANIZATION OF PROJECT AND PROJECT PROGRAM

ORGANIZATION OF PROJECT AND PROJECT PROGRAM

ORGANIZATION OF PROJECT

To accomplish the objectives of the Project, an organizational structure was developed (Figure 1) consisting of two technical units designated as branches under the over-all direction of the Project Director. These branches will be supported by an Administrative Office which will provide the necessary financial, procurement, personnel and miscellaneous services. The branches are further subdivided into sections having specific assignments and responsibilities. Following is a brief description of the various Project units and a summary of their functions.

Technical Operations Branch

This Branch has been divided into the following four Sections: Field Measurement, Laboratory, Inventory, and Data Processing. The responsibility of the Branch Chief is to provide over-all guidance for the Section Chiefs and to coordinate their activities. The Branch Chief will also interpret findings of field studies and determine the sufficiency of data supporting the interpretations.

Field Measurement Section

This Section is responsible for securing stream flow measurements at various sampling stations, for the collection and transportation of field samples to the laboratory except for biological sampling, and for special field surveys necessary to secure supporting data or information.

Laboratory Section

There is established in this Section four major laboratories. The Chemical Laboratory will be responsibile for chemical determinations including the biochemical oxygen demand. The Bacteriological Laboratory will be responsible for determining bacterial concentrations from the samples collected for this purpose. The Biological Laboratory will be responsible for studies of the aquatic life existing in the various sampling areas including the collection of biological samples. The Radiological Laboratory will be responsible for determining and reporting on the levels of radioactivity in the study area.

Inventory Section

The Inventory Section is responsible for the development of inventories of municipal wastes, industrial wastes, municipal and industrial water supplies, water resources, and water uses.

Data Processing Section

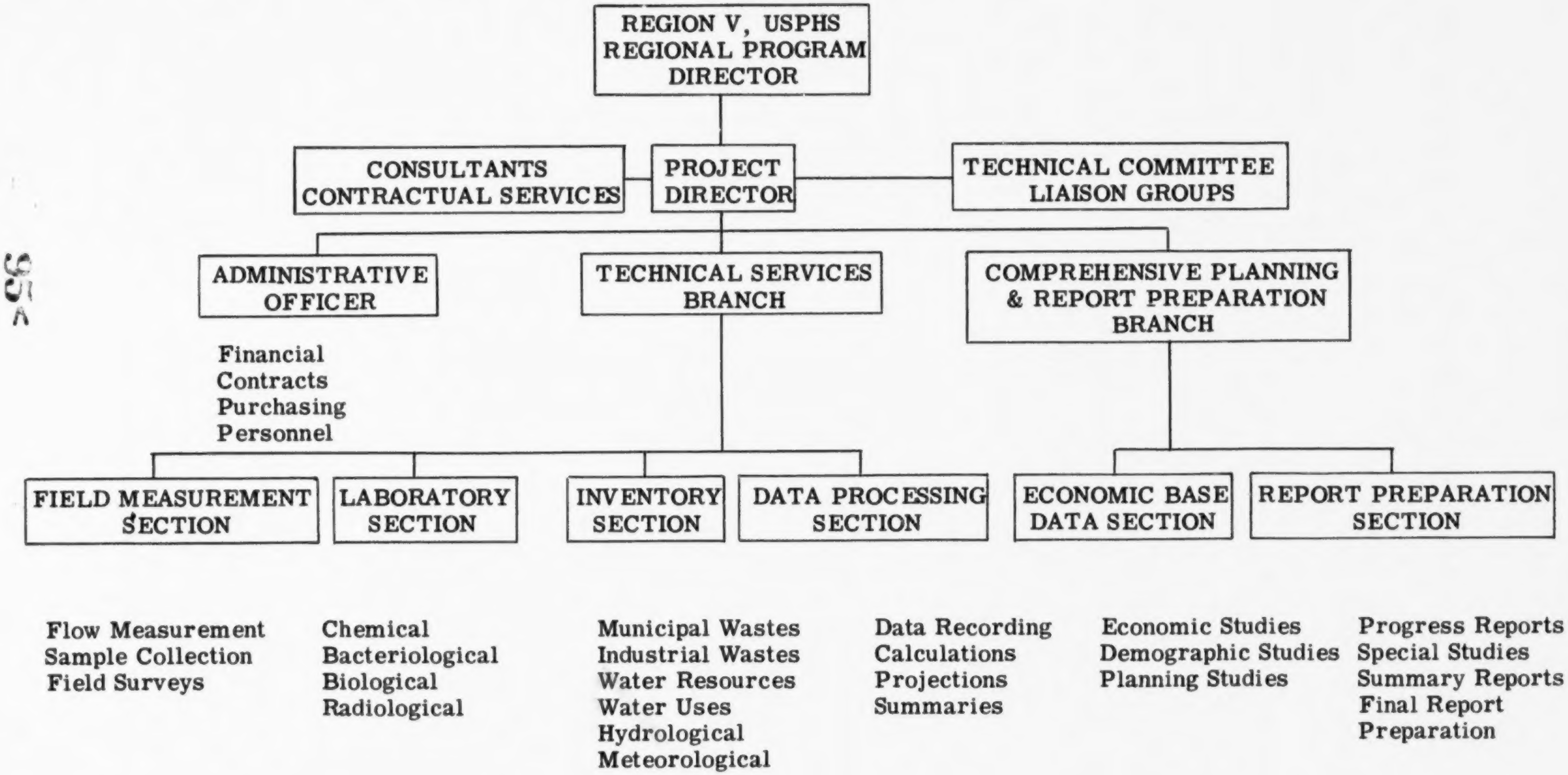
This Section is responsible for developing a program for the recording and storing of all data in such manner that it will be readily available for summary, computations, or analysis as desired by the Chief of the Technical Services Branch. Data which can be expressed mathematically will be channeled to the Data Processing Section.

Comprehensive Planning and Report Preparation Branch

This Branch is responsible for the over-all planning of the various Project programs. Data and analytical results secured by the Technical Services Branch will be channeled to the Comprehensive Planning and Report Preparation Branch for review and coordination with other Project phases. The final interpretation of all data in cooperation with principals of the Technical Services Branch will, then, be the responsibility of this Branch to make certain that special studies necessary to provide proper data interpretation are undertaken by the Technical Operations Branch. This Branch also is responsible for the preparation of the final report, including the formulation of any recommendations.

FIGURE 1

ORGANIZATION
GREAT LAKES-ILLINOIS RIVER BASINS PROJECT


REGION V, USPHS REGIONAL PROGRAM DIRECTOR
CONSULTANTS CONTRACTUAL SERVICES
PROJECT DIRECTOR
TECHNICAL COMMITTEE LIAISON GROUPS
ADMINISTRATIVE OFFICER
TECHNICAL SERVICES BRANCH
COMPREHENSIVE PLANNING & REPORT PREPARATION BRANCH
Financial
Contracts
Purchasing
Personnel
FIELD MEASUREMENT SECTION
LABORATORY SECTION
INVENTORY SECTION
DATA PROCESSING SECTION
ECONOMIC BASE DATA SECTION
REPORT PREPARATION SECTION
Flow Measurement
Sample Collection
Field Surveys
Chemical
Bacteriological
Biological
Radiological
Municipal Wastes
Industrial Wastes
Water Resources
Water Uses
Hydrological
Meteorological
Data Recording
Calculations
Projections
Summaries
Economic Studies
Demographic Studies
Planning Studies
Progress Reports
Special Studies
Summary Reports
Final Report
Preparation

The Comprehensive Planning and Report Preparation Branch is divided into two sections, the Economic Base Study Section and the Comprehensive Report Preparation Section.

Economic Base Studies Section

The Economic Base Studies Section is responsible for economic, demographic, and area planning studies and the development of projections of future economic and population growth for the Project area. This information will in turn be used to develop future water demands, projected water uses, and anticipated future waste discharges.

Report Preparation Section

This Section has over-all responsibility for reviewing, editing and rewriting sections of the final report and for the preparation of final reports. The Project will secure counsel and advice from the Technical Committee to the Great Lakes-Illinois River Basins Project appointed by the Surgeon General and from various advisory and coordinating committees and groups from agencies interested in the Project objectives. Technical assistance to the Project is available through consultants in various specialized fields. When deemed to be in the public interest, certain Project activities will be accomplished through contracts with recognized agencies and organizations having competency in specialized fields.

THE GREAT LAKES-ILLINOIS RIVER BASINS PROGRAM

Fiscal Year 1961

1. Inventory of Waste Sources.

   Development of an inventory of sources of pollution reaching the Illinois Waterway and its major tributaries. Known significant sources have been tabulated. Considerable work remains to be done in filling gaps in the available information.

2. Location of Unknown Pollution Sources.

   An attempt to locate concealed or unknown sources of pollution through the use of aerial photography was scheduled for 1961. Films taken during the first flight are now being examined. Further studies utilizing infra-red scanning devices as a means of locating sources will be undertaken during FY 1962.

3. Industrial Wastes.

   Sampling of significant sources of industrial wastes has been scheduled for early FY 1962 as soon as the permanent laboratories for the Project are in use. Information secured from this activity will bring existing records up-to-date and fill gaps in the industrial waste inventory.

4. Field Measurement and Analysis.

   The sampling of 39 stations at strategic points along the Illinois Waterway and major tributaries was started April 19. This work will be continued until sufficient data are obtained to secure a clear picture of the condition of waterways under various climatic conditions. It is expected that this will require about one year. Sampling from an additional 22 stations below the Kankakee River will be undertaken as laboratory and personnel permit.

5. Storm Water Overflows.

   Plans for sampling selected overflows from the Chicago Sewer System are to be completed during the year with the sampling to start during the summer of 1961. This work will be scheduled for completion during FY 1962. This study should give a clearer picture of the impact of storm water overflows on the various watercourses in the Chicago area and should provide the basis for a program of gradual reduction in pollution attributed to this source.

6. Lake Michigan Current Studies.

   Contracts were let with the Corps of Engineers for research and experimentation in the design and construction of a suitable current measuring station. Contracts for a prototype station will be let. The studies included under this contract will also cover a telemetering system for relaying data from the station to a shore receiving station.

7. Lake Model Study.

A contract was let to the Waterways Experiment Station of the Corps of Engineers for research work which will lead to the construction of a pilot model of Lake Michigan to investigate the various physical phenomena connected with lake currents.

Fiscal Year 1962

1. Inventory of Waste Sources.

Inventory of waste sources in the Chicago area will be completed during this year. The inventory program will then be extended during the latter part of FY 1962 to include sources directly tributary to Lake Michigan.

2. Location of Unknown Pollution Sources.

Aerial photography will again be employed in the location of sources of pollution along the shores of Lake Michigan if the results secured from the Illinois Waterway warrant continuation of this study.

3. Field Measurements and Analysis.

Sampling in the Illinois Waterway and its major tributaries will be completed near the end of FY 1962. Some sampling will be started in Lake Michigan during the year. This sampling will be primarily of a reconnaissance type intended to permit developing detailed plans for sampling in Lake Michigan during FY 1963.

4. Industrial Wastes.

Sampling of significant industrial waste sources will be continued.

5. Storm Water Overflows.

Studies of storm water overflows will be completed.

6. Lake Current Studies.

Installation of a prototype station for field testing will be completed. Observation of results secured from testing of instrumentation to be employed in the Lake Michigan current measuring program will be continued. Detailed plans will be prepared for the construction and installation of stations to be installed in Lake Michigan. If funds permit, contracts will be let for additional units to be installed late in 1962 or early 1963.

7. Pilot Model Lake Study.

Preliminary studies will be completed during the year and if funds are available construction will start on the pilot model. The extent of the work done will be dependent upon the time required for design and fabrication of the pilot model.

8. Economic Base Studies.

Economic base studies in Chicago and Lake Michigan areas will be started in FY 1962. It is expected that these studies will require 12 to 18 months. These studies should facilitate projections of future development in the area and permit evaluation of their impact on water quality.

Fiscal Year 1963

1. Illinois Waterway Studies.

Any unfinished activities or special studies of the Illinois Waterway will be completed. Preparation of final report will be undertaken.

2. Inventory of Waste Sources.

Inventory of waste sources tributary to Lake Michigan will be completed. Studies of waste sources tributary to Lake Huron will be started.

3. Field Measurement and Analysis.

Extensive sampling of Lake Michigan will be undertaken.

4. Lake Michigan Current Studies.

Installation of all current measuring stations will be completed. Stations to be operated continuously for one year.

5. Lake Michigan Model Study.

Completion and operation of the Lake Michigan pilot model is scheduled for the year.

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6. Economic Base Studies.

Economic base studies will be continued.

Fiscal Years 1964 - 1965 - 1966

Inventory, field measurement and analysis, economic base studies and lake current measurements will be undertaken successively in Lakes Huron, Superior, Erie, and Ontario. Report preparation will follow completion of field studies in each area.

APPENDIX III

TESTS AND THEIR SIGNIFICANCE DEFINITION OF TERMS

TESTS AND THEIR SIGNIFICANCE
DEFINITION OF TERMS

TESTS AND THEIR SIGNIFICANCE

In the assessment of water quality, many tests are available which indicate the fitness of water for particular applications. However, it has long been established that certain basic water quality conditions are necessary to maintain a stream in such a condition that its contents can serve a multitude of beneficial uses such as public water supply, industrial and agricultural water use, aquatic life and wildlife propagation, and recreation. The significance of tests used to determine water quality and water pollution in the study area are described below.

Hydrogen Ion Concentration (pH), in pH Units

pH is a shorthand mathematical expression of hydrogen ion concentration, or more specifically, hydrogen ion activity. The dividing line between an "acid" and an "alkali" is pH 7, the neutral point. pH values below 7 indicate an acid condition, values above 7 indicate an alkaline condition. Each unit change in pH indicates a tenfold change in hydrogen ion concentration; thus pH 6 is 10 times stronger in acidity than pH 7, and pH 5 is 100 times stronger than pH 7.

The significance of pH to water quality cannot be overemphasized. Low pH values (acidity) disrupt biological activity, cause corrosion of steel and concrete, intensify the effect of toxic materials such as sulfide and cyanide, interfere with water plant coagulation practices and tend to add undesirable iron and manganese to the water. High pH values (alkalinity) also disrupt biological activity, precipitate calcium and magnesium from water and increase the toxicity of ammonia and other amines.

Temperature, in Degrees Centigrade (°C)

The temperature of water is usually the result of natural phenomena. However, multiple usage by man has often resulted in significant changes in the normal temperature ranges of a stream and has upset the life cycles of the aquatic biota.

Temperature controls the concentration of oxygen which can be dissolved in water. This is an inverse relationship in that less oxygen can dissolve as the temperature rises. For example, at sea level barometric pressure (760 mm. mercury), the saturation value is 14.6 milligrams per liter at 0°C and 7.6 milligrams per liter at 30°C. Temperature also affects the rate of oxygen utilization by decomposing organic matter; the rate increasing with rising temperature. Thus, high water temperatures affect dissolved oxygen in two ways: first, in lowering the saturation value and second, in speeding the consumption of oxygen. Unnaturally high temperatures may cause the death of fish, and disrupt normal biological activities. The efficiency of water for industrial cooling processes, including steam power generation, decreases as temperature increases.

Dissolved Oxygen (DO), in Milligrams Per Liter (mg/l)

Dissolved oxygen is perhaps the most important single quality of water necessary for a healthy, balanced, aquatic environment. Dissolved oxygen is consumed by organisms through respiration and is constantly replenished, if a well-balanced environment exists, by absorption from the atmosphere and through oxygen production by phytoplankton, attached algae and higher aquatic plants. When organic pollution enters this environment, the balance is altered. The bacteria, present in the water or introduced with pollution, utilize the organic matter as food and multiply rapidly. If they consume oxygen at a rate greater than the rate of atmospheric reaeration and photosynthetic oxygenation, an unbalance in the stream is created which results in an oxygen deficiency. This may be great enough to cause death of fish and other desirable organisms and to convert the stream into an odoriferous nuisance.

The dissolved oxygen test serves to determine the oxygen level in the stream as an index of this aspect of the health of the stream.

Biochemical Oxygen Demand (BOD), in Milligrams Per Liter (mg/l)

The biochemical oxygen demand of sewage, sewage plant effluents, polluted waters, or industrial wastes is exerted by three classes of materials: (a) carbonaceous organic materials useable as a source of food by aerobic organisms; (b) oxidizable nitrogen derived from nitrite, ammonia, and organic nitrogen compounds which serve as food for specific bacteria; and (c) certain chemical reducing compounds which will react rapidly with molecularly dissolved oxygen. In raw and settled domestic sewage, most of the oxygen demand is due to the first class of materials and is determined by the biochemical oxygen demand test. In biologically treated effluents, a considerable proportion of the oxygen demand may be due to oxidation of class (b) compounds. Class (c) materials are less frequently involved in stream pollution than the first two. Certain industrial wastes are the sources of most of the third class of materials, which are detected only by special manipulation of the BOD determination. It should be understood that all three of these classes when present have a direct bearing upon the oxygen balance of the receiving waters and must be considered in the discharge of a waste to such a water.

The BOD test is in the nature of a bioassay rather than a well defined chemical reaction. It depends upon the activity of microorganisms in converting unstable organic matter into cellular material, utilizing the waste material as energy to effect this conversion. As a bioassay, toxic substances if present adversely influence this test.

As dissolved oxygen is used by the microorganisms during the process of organic decomposition, the test routinely consists of measuring the dissolved oxygen initially present and that remaining after incubation in the dark for a stated time interval, for example five days at a selected temperature, generally 20° C. Special determinations made at frequent intervals over an extended period of time are necessary to measure the rate at which oxygen demand is exerted.

The oxygen demand of the waste and the physical, chemical and biological characteristics of the receiving waters must be correlated in order to evaluate stream conditions and to design waste treatment facilities.

In general, higher BOD values can be expected to result in lower dissolved oxygen levels in the receiving waters, a less favorable environment to fish and other desirable aquatic life, greater need for chlorine and chemicals for water treatment, and a deterioration of the quality of treated water, due to tastes and odors resulting from the breakdown of organic matter.

Coliform Organisms in Numbers per 100 Milliliters (ml)

The coliform group of bacteria are defined as including all of the aerobic and facultative anaerobic, Gram negative, non spore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35° C. This group name is synonymous with the "B. Coli" or "Coli-aerogenes" group, as described by earlier standard texts. The significance to water quality is that the origin of most of this group is from the intestinal tract of warm-blooded animals, including man. Consequently, the presence of these organisms is an indicator of contamination of the water by fecal matter. Contamination by fecal matter constitutes a hazard of transmission of certain water-borne diseases since these diseases are communicable through the use of water containing pathogenic, fecal organisms.

The organisms, as such, usually do not cause disease, but their presence in water indicates contamination from enteric sources which may also include pathogenic bacteria. The concentrations of coliforms found in water are, therefore, related to the degree of pollution of enteric origin.

There are two standard procedures for determining coliform density. The MPN (most probable number) procedure, long used in this field, results in a number which is a statistically derived representation of the density. The MF (membrane filter) procedure, more recently developed, is a direct count. The MF procedure was used in this survey.

Radioactivity - Total Alpha or Beta Activity Concentrations ($\mu\mu c/l$)

This is a measure of the radioactivity present in water due to the emission of alpha or beta particles. The radioactivity content of waters, if excessive, will impair their usefulness for many purposes, primarily those which result, directly or indirectly, in the ingestion of radioactive materials by humans. Continuous human ingestion of even minute quantities of radioactive materials can cause bodily damage due to the beta or alpha particles given off during the radioactive decay of these elements within the body. Radioactivity concentrations in water are reported as activity per unit volume, such as micromicrocuries per liter.

Biological

The biological examination of water, sewage sludge, or bottom materials embraces a qualitative analysis of the kinds of floating and bottom organisms present and a quantitative estimate of their number or bulk. Such information aids in the interpretation of the various physical and chemical analyses of water, indicates pollution by sewage or industrial wastes, determines the progress of the self purification of streams, explains the mechanism of biological sewage treatment, and assists in the study of the ecology of the water environment.

DEFINITION OF TERMS

Milligrams Per Liter

Milligrams per liter is the weight expressed in milligrams of dry solids per liter of solution. One milligram is a little less than four hundred thousandths of an ounce, and a liter is a little more than a quart. Analytical results may also be parts per million (ppm). Assuming that one liter of water, sewage, or industrial waste weighs one kilogram (2.2 pounds), one milligram per liter is equivalent to one part per million. When dealing with industrial wastes of high specific gravity, results should be expressed in milligrams per liter, with the specific gravity given. Results obtained in mg/l can be converted to ppm by the formula:

$$\text{ppm by weight} = \frac{\text{mg/l}}{\text{Specific Gravity}}$$

One ppm may be expressed as 8.345 pounds of dry solids to one million U. S. gallons of water. Occasionally analytical results may be expressed as parts per billion (ppb) when dealing with extremely low concentrations.

Waste Treatment

Waste treatment is any controlled process to which waste is subjected in order to remove or alter its objectional constituents and thus render it less offensive or dangerous. As a general rule liquid waste waters must finally be disposed of into natural waters. Discharge to waterways can cause degradation of receiving water quality and interfere with other legitimate uses. The objective of waste treatment is to prepare the waste for ultimate disposal. The designer of treatment works should consider both the treatment and final disposal as one integral design to develop a proper solution.

Population Equivalents, BOD

Population equivalent of a waste is the calculated population which would normally contribute the same amount of BOD per day as the waste under consideration. If the polluting matter present in industrial wastes contains decomposable organic matter, as does municipal sewage, it may then be measured by the BOD test. Knowing the volume of flow, the total amount of the BOD in pounds per day can be determined. The organic load contributed by the sewage of one person per day varies, but an average quantity of one sixth (.167) pounds per day of 5-day 20°C BOD is a commonly used figure. The industrial waste loading in pounds BOD divided by .167 pounds yields the population equivalent of the waste load.

$$\text{PE} = \frac{\text{Industrial Waste Load in Pounds/day of BOD}_5}{\text{.167 Pounds/day}}$$

Influent

The raw wastes arriving at the waste treatment plant.

Effluent

The waste discharged either from a waste treatment plant or an outfall such as a storm water overflow.

Units of Flow, Cubic Feet per Second and Million Gallons per Day

Cubic feet per second (cfs) and million gallons per day (mgd) are terms commonly used to express quantities of liquid moving past a point per unit of time. Cubic feet per second is generally used to express stream flow, while million gallons per day is used to indicate flow in man-made structures such as water treatment and waste treatment plants. One term can readily be converted to the other by the following formulae:

$$\text{cfs} \times .646317 = \text{mgd}$$
$$\text{mgd} \times 1.54723 = \text{cfs}$$

Curie

A measure of the rate of radioactive decay or disintegrations per unit time. A curie is equivalent to the activity of one gram of radium. Fractional amounts are: millicurie (one thousandth), microcurie (one millionth), micromicrocurie (one millionth of a microcurie).

Alpha, Beta or Gamma Activity

The rates of disintegration accompanied by the emission of alpha or beta particles or gamma photons, respectively, reported in curies or fractions thereof. Alpha particles are heavy and have a short penetrating range when compared to beta particles. Gamma photons are electromagnetic waves of much greater penetrating power.

Maximum Permissible Concentration (MPC)

The concentration of a radioisotope in water which, if consumed over a lifetime, will result in a radiation exposure believed to have negligible effects. MPCU is the maximum permissible concentration which is applied to a mixture of unknown radioisotopes.

Algae

Simple floating or attached plants containing photosynthetic pigments which enable them to synthesize carbohydrates in the presence of sunlight. Most of these plants live in water; many of them are microscopic in size.

Plankton

A collective term covering all free floating and free swimming plants and animals. These are mostly microscopic and have relatively small powers of locomotion or none; thus, they drift in the water subject to the action of waves, currents and other forms of water movement.

Phytoplankton

A term covering the plant plankton (algae), that weakly swim or float in water.

Benthic Invertebrates

Those invertebrates that are associated with the bottoms of aquatic environments.

Biota

The flora and fauna of a region.

Bloodworm

A common name for insect larvae of the Family Tendipedidae. (See Tendipedidae.)

Caddis Fly

The insect order Tricoptera. The larvae are aquatic; adults terrestrial. Usually a clean water associated organism.

Clean Water Association

Complexes of biota that occur in natural situation, usually consisting of many kinds. Kinds not capable of surviving adverse environmental conditions usually are dominant.

Diversity of Organisms

A relative measurement of the number of kinds present in an environment.

Ekman Dredge

A dredge that samples a uniform area of the bottom (usually 36 square inches). Mechanical closure is made with high tension springs.

Fingernail Clam

Common name for a clam belonging to the Family Sphaeriidae. (See Sphaeriidae.)

Leech

A class of segmented worms typically possessing sucking discs.

Macrobenthic Invertebrates

Those benthic invertebrates whose presence may be observed with the naked eye (minimal size generally 0.5 to 1.0 mm.).

Mayfly

The insect order Ephemeroptera. The nymphs are aquatic; adults terrestrial. Usually clean water associated organisms.

Odonata

An insect order commonly known as dragonflies and damselflies. The immature forms are aquatic; the mature individuals are terrestrial.

Oligochaeta

A class of segmented worms. In aquatic environments of organic deposition and/or decomposition they are predominantly members of the Family Tubificidae.

Operculate Snail

A snail with an operculum or lid which closes the aperture of the shell. Such a snail has a gill form of respiration.

Petersen Dredge

A dredge that samples a uniform area of the bottom. Mechanical closure is made with the dredge's weight functioning through a lever system. Used in areas where a "stronger bite" is needed than can be obtained with an Ekman Dredge; i.e., rocky or gravel bottoms, coarse organic detritus, coarse aquatic plants, etc. Also used when stream velocity prohibits use of the lighter Ekman Dredge.

Polluted Water Association

Complexes of biota that are capable of surviving adverse environmental conditions resulting from human activities related to domestic, industrial and agricultural practices. Usually limited in numbers of kinds.

Production - Productivity

A time-rate unit of total amount of living organism(s) grown.

Pulmonate Snail

A snail lacking operculum with which to cover the shell aperture. This snail undergoes respiration via a pulmonary cavity or "lung."

Scud

A small aquatic crustacean of the order Amphipoda.

Sludge Worm

A common name for a group of various kinds of Oligochaetes. (See Oligochaeta.)

Sphaeriidae

A family of fresh-water clams. Usually small clams (up to one half inch maximum dimension) that are tolerant to a wide variety of environmental conditions.

Standing Crop

The amount of living material present at any given instance.

Tendipedidae

A family of the two winged flies, midges. Usually less than ten millimeters in length and tolerant of low dissolved oxygen environments. Larvae aquatic; adults terrestrial.

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APPENDIX IV

INVENTORY
MUNICIPAL WATER SUPPLIES

INVENTORY
MUNICIPAL WATER SUPPLIES

An inventory of municipal and semipublic water supplies in the Upper Illinois River Watershed above the Kankakee River junction has been compiled. The listing includes incorporated and unincorporated communities, subdivisions, institutions, and commercial establishments as motels. These data are tabulated as follows:

Table I.	North Branch Chicago River Lake and Cook Counties.
Table II.	Calumet - Sag Channel Lake, Indiana, and Will and Cook Counties.
Table III.	Illinois Waterway (Lake Michigan to Kankakee River) Will and Cook Counties.
Table IV.	Du Page River Will, Du Page and Cook Counties.
Table V.	Des Plaines River Lake, Cook, Will and Du Page Counties.
Table VI.	Five Subbasins Using Lake Michigan as Source of Water Supply.

Treatment methods are coded as follows:

P - Purification (including coagulation, filtration)

H - Softening

I - Iron or Manganese Removal

D - Disinfection

TABLE I
WATER SUPPLY DATA-SUMMARY

Major Basin Illinois Waterway	State Illinois	County Cook				
Sub-basin: North Branch Chicago River						
Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
Chicago (1) Source 1 & 2	Lake Mich.	3,550,404	D and PD	3,550,404	914.340(1)	
Evanston	Lake Mich.	79,283	PD	79,283	11.127	
Glencoe (2)	Lake Mich.	10,472	PD	10,472	1.252	
Glenview S. D.	Lake Mich. *	18,132	(PD)	18,132	2.610	*Via Wilmette
Kenilworth (2)	Lake Mich.	2,959	PD	3,000	0.385	
Glenview Countryside	4 Wells	7,500(E)	P	7,500(E)	.472	
Lincolnwood	Chicago	11,744	(D)	12,500	2.565	
Morton Grove	Chicago	20,533	(D)	20,543	3.075	Heavy industry
Niles	Chicago	20,393	(D)	21,000	2.727	
Northbrook	Lake Mich. *	11,635	(PD) D	11,635	1.149	*Via Glencoe
Northfield	Lake Mich. *	4,005	(PD)	3,800	.439	*Via Winnetka
Northfield Woods	Wells	2,000	D	2,000	.040	
Skokie	Lake Mich.	59,364	(PD)	62,000	9.404	Via Evanston
	Chicago				.031	Emergency only
Wilmette (2)	Lake Mich. *	28,268	PD	28,268	5.660	*Via Wilmette S. D.
Winnetka (2)	Lake Mich.	13,368	PD	*14,250	2.862	*Includes: Indian Hill area, Woodley Rd. area, Longmeadow Farm area, Longmeadow Meadows. Totalling some 882.
13 Communities less	Wells &	1,000	D mainly	1,600	0.314	
than 1,000	Chicago	434		500	0.056	
Sub Totals		3,840,494		3,846,887	958.508	
Upper Basin Illinois Major Basin Waterway	State Illinois	County Lake				
Sub basin: North Branch Chicago River						
LAKE COUNTY						
Deerfield*	Lake Mich.	11,786	(PD)	12,000	1.50	*From Highland Park
Gt. Lakes Naval Tr. Sta.	Lake Mich.	39,000	PD	39,000	5.75	
Highland Park	Lake Mich.	25,532	PD	37,500	4.93	Serves Deerfield & Bannockburn
Highwood	Lake Mich.	4,499	PD	4,500	0.36	
Park City	Well	1,408	None	1,400	0.14	
1 Community less than 1,000*	Lake Mich.	386	(PD)	400	0.04 E	*From Highland Park
2 Communities less than 1,000	Wells	280	None	300	0.03 E	
Sub Totals		82,891		95,100	12.75	
Total for North Branch Chicago River Sub basin: Lake & Cook Counties		3,924,385		3,941,987	971.258	

(1) Includes 904.967 M.G.D. to consumers in Chicago plus some 9.373 M.G.D. served to non-municipal consumers outside the City, such as industries, parks, schools, individual houses, etc. As these could not readily be broken down by Sub basin they have been lumped under the North Branch Chicago River Sub basin for convenience. The Chicago Water Works also serves some 61 suburban communities, the statistics on which are listed separately in their particular Sub basin. These total some 822,000 population served and a water usage of some 113.615 M.G.D. The total estimated population served by the Chicago Water Works is 4,373,000 and the total water usage is estimated at 1,028.0 M.G.D.

(2) These communities are physically located in the Lake Michigan Basin but their sewage is discharged to the North Side (MSD) treatment plant in the North Branch Chicago River Sub basin.

TABLE II
WATER SUPPLY DATA-SUMMARY

Major Basin Illinois	State Indiana	County Lake (Indiana) and Will (Illinois)
Sub basin: Calumet - Sag Channel		

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
Lake County, Indiana						
Dyer	Wells	3,993	D	2,300	0.210	
East Chicago	Lake Mich.	57,669	PD	56,000	15.841	
Griffith (1)	Lake Mich.	9,483	(PD)	9,400	0.550	Served by Gary-Hobart Corp.
Hammond (2)	Lake Mich.	111,698	PD	112,000 (2)	23.110	
Highland	Lake Mich.	16,234	(PD)	16,000	1.600	Served by Hammond
Munster	Lake Mich.	10,313	(PD)	10,000	1.000	Served by Hammond
Schererville	Wells	2,875	D	2,000	0.158	
Whiting	Lake Mich.	8,137	PD	8,000	1.740	
Black Oak and Ross communities and surrounding unincorporated area (3)	Wells and Lake Mich.	17,000	None & PD	2,300 (3)	0.230	
Sub-Totals		237,400		218,000	41.289	

(1) Griffith buys water from the Gary-Hobart Corp. whose source of supply is Lake Michigan.

(2) Hammond also serves Lansing, Ill., Highland Munster, and People's Water Company for a total population served of over 160,000.

(3) Unincorporated urbanized area which lies east of Highland and Griffith. People's Water Company which buys water from Hammond serves 2,300 people. The remaining 15,000 people are served by individual wells. Black Oak and Ross are old unincorporated communities surrounded by new subdivision activity.

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
Will County, Illinois						
Crete	Wells	3,463	D	3,500	0.174	
Steger	Wells	6,432	D	6,400	0.500	
3 Communities less than 1000	Wells	1,100	Some D	1,100	0.068	
Sub-Totals		10,995		11,000	0.742	
Totals for Sub-basin (Two Counties)		248,395		329,000	42.031	

Major Basin Illinois Waterway	State Illinois	County Cook
Sub basin:		

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
Alsip	Chicago	3,770	(D)	2,250	.090	Approx. 500 homes
Blue Island	Chicago	19,618	(D)	20,000	3.817	
Burnham-E. Side	Chicago	2,478	(D)	1,128	0.930	
W. Side	*Chicago		(D)	1,350	0.940	*Via Calumet City
Calumet City	Chicago	25,000	(D) D	25,000	2.544	Re-chlorinates
Carl Sandburg H.S.	Wells	1,300	None	1,300	.065 E	
Calumet Park	Chicago	8,448	(D)	8,500	0.721	
Chicago Heights	Wells	34,331	D	28,583	5.5	
Country Club Hills	Wells	3,421	PHID	3,421	.300	
Crestwood	Chicago	1,200	(D)	1,200 E	.060 E	
Dixmoor	Chicago	3,076	(D)	3,076	0.213	Via Harvey Line
Dolton	Chicago	18,746	(D)	20,000	1.682	
E. Hazelcrest	Chicago	1,457	(D)	1,457	0.025	Via I.C. R.R.
E. Chicago Heights*	Wells	3,270		800	0.035	*May have 2 separate systems
Evergreen Park	Chicago	27,178	(D)	25,000	2.189	
Flossmoor	Wells	4,624	D	5,000	0.609	

TABLE II (Continued)
WATER SUPPLY DATA-SUMMARY

Major Basin Illinois Waterway State Illinois County Cook

Sub basin: Calumet - Sag Channel

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
Grandview-Oaklawn		1, 500		1, 500 E	0. 075 E	
Harvey	Chicago	29, 071	(D)	30, 000	4. 118	
Hazelcrest	Chicago	6, 205	(D)	7, 208	0. 379	Via Harvey
Hometown	Chicago	7, 479	(D)	7, 479	0. 541	
Homewood	Rock Wells	13, 371	PHID	14, 000	1. 32	
Lansing	Lake Mich.	18, 098	(P, D) D	19, 000	1. 629	Via Hammond, Ind. and re-chlorinate.
Markham, S. D.	Chicago	11, 704	(D)	12, 000	0. 608	Via Harvey & Midlothian
Matteson	Rock wells	3, 225	None	3, 100	0. 255	Fourine adjustment
Merrionette Park	Chicago	2, 354	(D)	* 1, 900	. 158	Does not include Tr. Pk. of 500
Midlothian	*Chicago	6, 605	(D)	6, 605	. 348	Via Blue Island & Robbins
Oak Forest	Rock well	3, 724	D	4, 000	. 090	
Oak Lawn	Chicago	27, 471	(D)	30, 000	1. 862	
Oiympia Fields S. D.	Well	1, 503	D	1, 003	0. 060	
Orland Park	Rock wells	2, 592	D	2, 700	. 120	
Park Forest	Wells	29, 993	PHID	29, 993	2. 000	
Parkside Subd. - Tinley Park	Wells*	(2, 780)	(D)	2, 780 E	0. 139 E	*From Tinley Park
Phoenix	Chicago	4, 203	(D)	4, 400	. 307	Via Harvey
Posen	Chicago	4, 517	(D)	4, 517	. 292	Via Harvey
Riverdale	Chicago	12, 008	(D)	12, 008	2. 785	
Robbins	Chicago	7, 511	(D)	6, 000	0. 791	
Sauk Village-Indian Hill	Wells	2 600	D	2, 600 E	0. 213	
So. Chicago Heights	Rock wells	4, 043	D	*3, 900	0. 30	Approx. 30 families not served
South Holland	Chicago*	10, 412	(D)	10, 000	0. 817	*. 041 via Harvey *. 776 Direct
Southdale Subd. - Sauk Village	Sauk Village	1, 400	(D)	1, 400 E	0. 070 E	
Sundale Hills Subd. - Tinley Park	Tinley Pk.	1, 400	(D)	1, 400 E	0. 070 E	
Tinley Park	Rock wells	6, 392	D	6, 600	0. 350	Also serves Parkside Subd.
Thornton	Rock wells	2, 895	D	2, 895	0. 15	
Worth	Well	8, 196	D	1, 400	. 050	
Communities less than 1000	Wells	13, 747	Some D	13, 378	1. 028	
Sub Totals		404, 916		391, 751	40. 645	
Grand Total for Sub-basin - Cook & Will Counties of Ill. & Lake County, Indiana		653, 311		620, 751	82. 676	

TABLE III
WATER SUPPLY DATA-SUMMARY

Major Basin Illinois Waterway State Illinois County Will

Sub basin: Illinois Waterway (Lake Michigan to Kankakee River)

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
WILL COUNTY						
Bonnie Brae Sub-div.	Well	1,400	D	1,400	0.030	
Fairmont Area (Urban-Unincorporated)	Wells	7,000	D	7,000	0.175*	Served by Ill. Municipal Water Co. and many small sources, at 25 gpd rate.
Frankfort	Wells	1,135	Some D	1,100	0.063	
Ingalls Park Area (Urban-Unincorporated)	Wells	8,000	Some D	8,000	0.200**	**There are 4 urban-unincorporated areas around Joliet.
Joliet	Wells	71,559	D	71,600	7.714	
Lockport	Wells	7,560	D	7,600	0.671	
Manhattan	Wells	1,117	D	1,100	0.050	At 50 gpd rate.
Mokena	Wells	1,332	None	1,300	0.110	
New Lenox	Wells	1,732	Some D	2,700	0.065*	*Served by Ill. Municipal Water Co. and private wells.
Preston Heights Area (Urban-Unincorporated)	Wells	5,000	Some D	5,000	0.125**	
Ridgewood Area (Urban-Unincorporated)	Wells	5,000	Some D	5,000	0.125**	
12 Communities less than 1,000	Wells	5,676	Some D	5,700	0.234	
Sub Totals		116,511		117,500	9.562	
Total for Illinois Waterway Sub basin:						
Cook County		107,505		107,601	28.117	
Will County		116,511		117,500	9.562	
Grand Total		224,016		225,101	37.679	

Major Basin Illinois Waterway State Illinois County Cook

Sub basin: Illinois Waterway

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
Bedford Park	Chicago	737	(D)	730	9.802	114 Industries served.
Bridgeview	Wells	7,334	D	3,500	0.200 E	
	Chicago		(D)	3,834	0.130	Via So. Stickney S.D.
Central Stickney S.D.	Chicago	1,300	(D)	1,300 E	0.065 E	
Cicero	Chicago	69,130	(D)	69,130	13.709	
Forest View	Chicago	1,042	(D)	1,042	0.164	
Justice - Wesley Fields	Well	500 E	PHID	550 E	0.030	
Lemont	Rock wells	3,397	D	3,500	0.300	
Stickney	Chicago	6,239	(D)	6,239	1.084	
So. Stickney S.D.	Chicago	6,163	(D)	6,163	1.042	
Summit	Chicago	10,374	(D)	10,374	1.540	
4 Communities less than 1,000	Wells	1,239	Some D	1,239	0.051	
Sub Totals		107,505		107,601	28.117	

TABLE IV
WATER SUPPLY DATA-SUMMARY

Major Basin Illinois Waterway State Illinois County Du Page and Will

Sub basin: Du Page River

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
WILL COUNTY						
Crest Hill	Wells	5, 887	Some D	5, 500	0. 460*	*Paramount Water Co., Raynor Hills Water Co. & smaller sources
Plainfield	Wells	2, 183	D	2, 200	0. 244	
Plainfield(Rt. 30 to Joliet)	Wells	2, 000	Some D	2, 000	0. 100*	*Subdivision outside corporate limits
Rockdale	Wells	1, 272	D	1, 500	0. 190	
3 Communities less than 1, 000	Wells	1, 300	Some D	1, 300	0. 063*	*Estimated at 50 gpd
Sub Totals		12, 642		12, 500	1. 057	
DU PAGE COUNTY						
Black Hawk Heights	Well	1, 248	HD	1, 250	0. 170	
Glen Ellyn	Wells	15, 914	D	14, 400	1. 250	
Lisle	Well	4, 219	D	1, 500	0. 054	
Lombard	Wells	22, 561	D	25, 000	1. 700	
Naperville	Wells	12, 933	D	11, 500	1. 000	
Warrenville	Wells	3, 134	D	3, 800	0. 077	
West Chicago	Wells	6, 839	ID	5, 800	0. 600	
Wheaton	Wells	29, 197	D	22, 000	1. 500	
Winfield	Wells	1, 575	D	1, 570	0. 075	
42 Communities less than 1, 000	Wells	11, 815	Some D	10, 600	0. 682	
Sub Totals		109, 435		97, 420	7. 108	
DU Page Sub basin: Du Page River Totals for Cook, Du Page & Will Counties		124, 468		112, 911	8. 295	
Major Basin Illinois Waterway State Illinois			County Cook			
Sub basin: Du Page						
Bartlett	Wells	1, 540	D	1, 540	0. 082	
2 Communities less than 1, 000	Wells	851	D	1, 451 E	0. 048	
Sub Totals		2, 391		2, 991	0. 130	

TABLE V
WATER SUPPLY DATA-SUMMARY

ILLINOIS WATERWAY
Major Basin Upper Basin State Illinois County Lake

Sub basin: Des Plaines River

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
LAKE COUNTY						
Gray's Lake	Well	3,762	D	3,800	0.22	
Gurnee	Well	1,831	None	1,200	0.06	
Libertyville	Well	8,560	D	8,600	0.85	
Lindenhurst	Well	1,259	D	1,260	0.13	
Mundelein	Well	10,526	D	11,600	0.71	
Wildwood Subdivision	Well	2,000	D	2,000	0.20	
23 Communities less than 1000 population	Wells	4,933	None	5,000	0.54	
Sub-Totals		32,871		33,460	2.71	
Totals for Counties						
Cook		621,630		590,764	74.225	
Du Page		133,011		118,700	12.032	
Will		10,500		10,500	1.240	
Lake		32,871		33,460	2.710	
Grand Total		798,012		753,424	90.207	
Major Basin Illinois Waterway		State Illinois	County	COOK		
Sub basin: Des Plaines						
Arlington Heights	Wells	27,868	None	30,000	2.731	
Bellwood	Rock wells	20,729	D	21,000	3.0	
Berkeley	Chicago	5,792	(D)	5,792	0.670	Via Melrose Pk. Line
Berwyn	Chicago	54,224	(D) D	56,000	6.745	Re-chlorinates water
Broadview	Chicago	8,588	(D)	8,588	1.275	
Brookfield	Chicago	20,429	(D)	20,429	1.902	Via Brookfield-No. Riverside Water Commission.
Buffalo Grove Project	Wells		D	2,650	0.133 E	Priv. wells. Utility Co. has 530 meters. Est. 5 persons per meter.
Country Side Utility Co. Bridgeview		2,100				No record
Des Plaines	Wells	34,886	PHID	37,234	3.886	1 well under contruction
Elk Grove	Wells	6,608	D	8,500	.660	
Elmwood Park	Chicago	23,866	(D)	23,866	3.117	
Forest Park	Chicago	14,452	(D)	14,452	1.676	
Franklin Park, served by Fr. Pk. S.D.	Chicago	18,322	(D)	18,322	2.649	
Harwood Hts.	Chicago	5,688	(D)	5,000	0.767	Residents adjoining Chi. lines are served directly
Hillside	Chicago	7,794	(D)	7,794	0.902	Via Melrose Park Line by way of Hillside - Berkely Water Comm.
Hillside-Berkeley Water Com. *			Serves Hillside & Berkeley			*See each town
Hoffman Estates	Wells	8,776 E	D	8,776 E	0.613	
La Grange	Shallow wells	15,285	D	16,000	1.875	
La Grange Park	Chicago	13,793	(D)	13,793	1.164	
Leydon Twp.	Chicago	13,000 E	(D)	10,072	0.645	
Lyons	Rock wells	9,936	D	8,406 E	1.4	
Lyons	Chicago		(D)	1,530 E	0.256	

TABLE V (Continued)
WATER SUPPLY DATA - SUMMARY

Major Basin Illinois Waterway	State Illinois		County Cook			
Sub basin: Des Plaines						
Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
Maywood	Chicago	27, 330	(D)	27, 330	2. 809	Via Melrose Park Line
McCook	Chicago	400	(D)	400	3. 624	Serves heavy industry
Melrose Park	Chicago	22, 291	(D)	24, 000	4. 273	Via Melrose Park Line
Mount Prospect	Rock wells	18, 906	D	19, 806	1. 7	
Norridge S. D.	Chicago	14, 087	(D)	10, 000	0. 783	Est. 4, 000 not hooked up
Northlake Source #1	Chicago	12, 318	(D)	12, 500	0. 811	. 524 via Melrose Pk; . 287 via CNW R. R.
Source #2	Rock well		D		* . 100	Emergency supply
North Riverside S. D.	Chicago	7, 989	(D)	7, 989	0. 782	
Oak Park	Chicago	61, 093	(D)	61, 093	6. 682	
Palatine	Rock & Drift wells	11, 504	D	12, 000	0. 943	
Park Ridge	Chicago	32, 659	(D)	40, 000	3. 882	
River Forest	Chicago	12, 695	(D)	12, 695	1. 792	
River Grove	Chicago	8, 464	(D)	8, 464	1. 328	
Riverside Source #1	2 wells	9, 750	D	9, 750	0. 445	Water not separated
Source #2	Chicago		(D)		0. 583	Via N. Riverside Water Comm.
Rolling Meadows	Rock Wells	10, 879	D	11, 000 E	0. 652	
Schiller Park*	Chicago	5, 687	(D) D	8, 000	0. 915	*Includes Fairview Re-chlorinate
Stone Park	Chicago	3, 038	(D)	3, 038	0. 219	
Westchester	Chicago	18, 092	(D)	18, 092	2. 690	
Western Springs	Rock wells	10, 838	PHID	10, 838	0. 917	
Wheeling	Rock wells	7, 169	D	7, 600	0. 324	
60 Communities less than 1, 000	Wells & Chicago	14, 305	Some D	14, 562	1. 905	
Sub-Totals		621, 630		500, 764	74. 225	
Major Basin	State Illinois		County Will and DuPage			
Sub-basin: DES PLAINES RIVER						
Will County						
Hampton Park (Romeoville Village)	Wells	5, 000	D	5, 000	0. 116	
Statesville Penitentiary	Wells	4, 000	D	4, 000	1. 050	
2 Communities less than 1, 000	Wells	1, 200	D	1, 200	0. 057	
1 Community less than 1000	Wells	300	None	300	0. 017	
Sub-Totals		10, 500		10, 500	1. 240	
Du Page County						
Addison	Wells	6, 730	D	2, 000	0. 340	
Bensenville	Wells	10, 233	D	10, 200	0. 954	
Clarendon Hills	Wells	5, 850	HID	5, 800	0. 460	Some Crenothrix trouble
Downers Grove	Wells	21, 154	HD	20, 000	2. 000	
Elmhurst	Wells	36, 991	D	37, 000	3. 572	
Hinsdale	Wells	12, 859	HID	12, 900	2. 005	
Itasca	Wells	3, 564	D	3, 200	0. 154	
Roselle	Well	3, 579	D	3, 600	0. 600	
Salt Cr. -Villa Park	Wells	20, 391	D	15, 600	1. 583	Some water shortage
Westmont	Wells	5, 977	HID	4, 700	0. 150	
16 Communities less than 1, 000	Wells	5, 683	Some D	3, 700	0. 214	
Sub-Totals		133, 011		118, 700	12. 032	

TABLE VI
WATER SUPPLY DATA-SUMMARY

Major Basin Illinois Waterway	State Illinois & Indiana	County				
Sub basin: Sub basins using Lake Michigan as water supply						
Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
SUB-BASINS	All from Lake Michigan					
North Branch Chicago River(1)		3, 912, 197		3, 929, 187(1)	970. 262(1)	
Illinois Waterway (Lake Michigan to Kankakee River)		102, 319		98, 812	27. 540	
Calumet & Sag Channel		489, 143		473, 778	72. 917	
Des Plaines River		434, 555		427, 717	53. 121	
Totals		4, 938, 214		4, 929, 494	1, 123. 840	

(1) Figures include all of Chicago and suburban non-municipal users served by the Chicago Water Works (lumped under the North Branch Chicago River Sub basin for convenience) plus the suburban municipalities in this Basin served by the Chicago Water Works plus municipalities along Lake Michigan which discharge sewage to the North Side (MSD) treatment plant in this Sub basin. Altogether, the Chicago Water Works serves an estimated population of 4, 373, 000 with a total usage estimated at 1, 028. 0 M. G. D.

Major Basin Illinois Waterway	State Illinois	County Cook & Lake				
Sub basin: North Branch Chicago River						
COOK COUNTY						
Chicago #1 & #2	Lake Mich.	3, 550, 404	D & PD	3, 550, 404	914. 340	
Evanston	Lake Mich.	79, 283	PD	79, 283	11. 127	Sewage to N.S.T.P.
Glencoe	Lake Mich.	10, 472	PD	10, 472	1. 252	Sewage to N.S.T.P.
Glenview	Lake Mich.	18, 132	(PD)	18, 132	2. 610	From Wilmette S.D.
Kenilworth	Lake Mich.	2, 959	PD	3, 000	0. 385	Sewage to N.S.T.P.

Lincolnwood	Lake Mich.	11,744	(D)	12,500	2.565	From Chicago System
Morton Grove	Lake Mich.	20,533	(D)	20,543	3.075	From Chicago System and for heavy industry
Niles	Lake Mich.	20,393	(D)	21,000	2.727	From Chicago System
Northbrook	Lake Mich.	11,635	(PD) D	11,635	1.149	From Glencoe
Northfield	Lake Mich.	4,005	(PD)	3,800	0.439	From Winnetka
Skokie	Lake Mich.	59,364	(PD)	62,000	9.435	From Evanston
Wilmette	Lake Mich.	28,268	PD	28,268	5.660	From Wilmette S.D.
Winnetka	Lake Mich.	13,368	PD	14,250	2.862	From Winnetka S.D.
1 Small Community	Lake Mich.	434	(D)	500	0.056	From Chicago System
Total for Cook Co.		3,830,994		3,835,787	957.682	
LAKE COUNTY						
Deerfield	Lake Mich.	11,786	(PD)	12,000	1.500	From Highland Park
Gt. Lakes Naval Tr. Sta.	Lake Mich.	39,000	PD	39,000	5.750	
Highland Park	Lake Mich.	25,532	PD	37,500	4.930	
Highwood	Lake Mich.	4,499	PD	4,500	0.360	
1 Small Community	Lake Mich.	386	(PD)	400	0.040 E	From Highland Park
Total for Lake Co.		81,203		93,400	12.580	
Grand Total for N.B.C.R.		3,912,197		3,929,187	970.262	

Major Basin Illinois Waterway State Illinois County Cook

Sub basin: Illinois Waterway (Lake Michigan to Kankakee River)

COOK COUNTY						
Bedford Park	Lake Mich.	737	(D)	730	9.802	From Chicago System 114 industries served
Bridgeview	Lake Mich.	7,334	(D)	3,834	0.134	From Chicago System via So. Stickney S.D.
Central Stickney S.D.	Lake Mich.	1,300	(D)	1,300 E	0.065 E	From Chicago System
Cicero	Lake Mich.	69,130	(D)	69,130	13,709	From Chicago System
Forest View	Lake Mich.	1,042	(D)	1,042	0.164	From Chicago System
Stickney	Lake Mich.	6,239	(D)	6,239	1.084	From Chicago System
So. Stickney S.D.	Lake Mich.	6,163	(D)	6,163	1.042	From Chicago System
Summit	Lake Mich.	10,374	(D)	10,374	1.540	From Chicago System
Total for Cook Co.		102,319		98,812	27.540	

TABLE VI Continued
WATER SUPPLY DATA-SUMMARY

Major Basin Illinois Waterway | State Illinois & Indiana | County Cook, Illinois and Lake, Indiana

Sub basin: Calumet and Sag Channel

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
COOK COUNTY						
Alsip	Lake Mich.	3 770	(D)	2,250	0.090	From Chicago System
Blue Island	Lake Mich.	19,618	(D)	20,000	3.817	From Chicago System
Burnham E. & W. Side	Lake Mich.	2,478	(D)	2,478	1.870	From Chicago System
Calumet City	Lake Mich.	25,000	(D) D	25,000	2.544	From Chicago System and re-chlorinates
Calumet Park	Lake Mich.	8,448	(D)	8,500	0.721	From Chicago System
Crestwood	Lake Mich.	1,200	(D)	1,200 E	0.060 E	From Chicago System
Dixmoor	Lake Mich.	3,076	(D)	3,076	0.213	From Chicago System and Harvey line
Dolton	Lake Mich.	18,746	(D)	20,000	1.682	From Chicago System
E. Hazelcrest	Lake Mich.	1,457	(D)	1,457	0.025	From Chicago System and I.C.R.R.
Evergreen Park	Lake Mich.	27,178	(D)	25,000	2.189	From Chicago System
Harvey	Lake Mich.	29,071	(D)	30,000	4.118	From Chicago System
Hazelcrest	Lake Mich.	6,205	(D)	7,208	0.379	From Chicago System and via Harvey
Hometown	Lake Mich.	7,479	(D)	7,479	0.541	From Chicago System
Lansing	Lake Mich.	18,098	(PD) D	19,000	1.629	From Hammond, Ind. and re-chlorinate
Markham S.D.	Lake Mich.	11,704	(D)	12,000	1.608	From Chicago System and via Harvey
Merrionette Park	Lake Mich.	2,354	(D)	1,900	0.158	From Chicago System
Midlothian	Lake Mich.	6,605	(D)	6,605	0.348	From Chicago System and via Blue Island
Oaklawn	Lake Mich.	27,471	(D)	30,000	1.862	From Chicago System
Phoenix	Lake Mich.	4,203	(D)	4,400	0.307	From Chicago System
Posen	Lake Mich.	4,517	(D)	4,517	0.292	From Chicago System and via Harvey
Riverdale	Lake Mich.	12,008	(D)	12,008	2.785	From Chicago System
Robbins	Lake Mich.	7,511	(D)	6,000	0.791	From Chicago System
So. Holland	Lake Mich.	10,412	(D)	10,000	0.817	From Chicago System
Total for Cook Co.		258,609		260,078	28.846	

Major Basin Illinois Waterway | State Indiana | County Lake

Sub basin: Calumet and Sag Channel

LAKE COUNTY						
East Chicago	Lake Mich.	57,669	PD	56,000	15.841	
Griffith	Lake Mich.	9,483	(PD)	9,400	0.550	From Gary-Hobart Corp.
Hammond	Lake Mich.	111,698	PD	112,000	23.110	
Highland	Lake Mich.	16,234	(PD)	16,000	1.600	From Hammond System
Munster	Lake Mich.	10,313	(PD)	10,000	1.000	From Hammond System
Whiting	Lake Mich.	8,137	PD	8,000	1.740	
Black Oak and Ross	Lake Mich.	17,000	(PD)	2,300	0.230	From Hammond System
Total from Lake Co.		230,534		213,700	44.071	
Totals for Lake & Cook Co.		489,143		473,778	72.917	

TABLE VI Continued
WATER SUPPLY DATA - SUMMARY

Major Basin Illinois Waterway	State Illinois	County Cook
Sub basin: Des Plaines River		

Community, Sewer or Sanitary District, Institution	Source of Supply	1960 Population	Treatment	Estimated Population Served	Estimated Usage MGD	Remarks
COOK COUNTY						
Berkeley	Lake Mich.	5, 792	(D)	5, 792	0. 670	From Chicago System
Berwyn	Lake Mich.	54, 224	(D) D	56, 000	6. 745	From Chicago System and re-chlorinates
Broadview	Lake Mich.	8, 588	(D)	8, 588	1. 275	From Chicago System
Brookfield	Lake Mich.	20, 429	(D)	20, 429	1. 902	From Chicago System and Brookfield System
Elmwood Park	Lake Mich.	23, 866	(D)	23, 866	3. 117	From Chicago System
Forest Park	Lake Mich.	14, 452	(D)	14, 452	1. 676	From Chicago System
Franklin Park	Lake Mich.	18, 322	(D)	18, 322	2. 649	From Chicago System
Harwood Hts.	Lake Mich.	5, 688	(D)	5, 000	0. 767	From Chicago System
Hillside	Lake Mich.	7, 794	(D)	7, 794	0. 902	From Chicago System and Melrose Line
Leyden Twp.	Lake Mich.	13, 000 E	(D)	10, 072	0. 645	Via Melrose Line.
La Grange Park	Lake Mich.	13, 793	(D)	13, 793	1. 171	From Chicago System
Lyons	Lake Mich.	9, 936	(D)	1, 530	0. 256	From Chicago System
Maywood	Lake Mich.	27, 330	(D)	27, 330	2. 809	From Chicago System and Melrose Line
Mc Cook	Lake Mich.	400	(D)	400	3. 647	From Chicago System Serves heavy industry
Melrose Park	Lake Mich.	22, 291	(D)	24, 000	4. 273	From Chicago System
Norridge, S. D.	Lake Mich.	14, 087	(D)	10, 000	0. 783	From Chicago System
Northlake No. 1	Lake Mich.	12, 318	(D)	12, 500	0. 811	From Chicago System and Melrose & C. N. W. R. R.
North Riverside S. D.	Lake Mich.	7, 989	(D)	7, 989	0. 782	From Chicago System
Oak Park	Lake Mich.	61, 093	(D)	61, 093	6. 682	From Chicago System
Park Ridge	Lake Mich.	32, 659	(D)	40, 000	3. 882	From Chicago System
River Forest	Lake Mich.	12, 695	(D)	12, 695	1. 792	From Chicago System
River Grove	Lake Mich.	8, 464	(D)	8, 464	1. 328	From Chicago System
Riverside #2	Lake Mich.	9, 750	(D)	5, 500	0. 583	From Chicago System
Schiller Park	Lake Mich.	5, 687	(D) D	8, 000	0. 915	From Chicago System and re-chlorinates
Stone Park	Lake Mich.	3, 038	(D)	3, 038	0. 219	From Chicago System
Westchester	Lake Mich.	18, 092	(D)	18, 092	2. 690	From Chicago System
4 Small Communities	Lake Mich.	2, 778	(D)	2, 978	0. 150 E	From Chicago System
Totals from Cook Co.		434, 555		427, 717	53. 121	

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